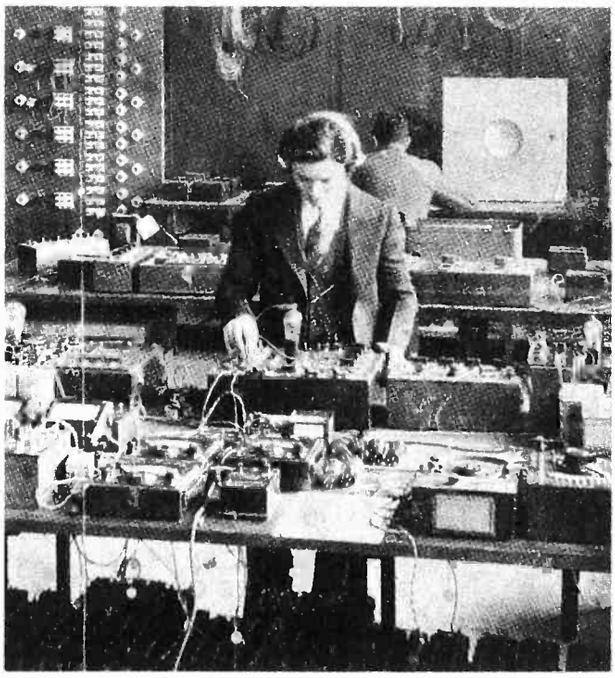
electronics

electron tubes—their radio, audio, visio and industrial applications

radio
sound pictures
telephony
broadcasting
telegraphy
carrier systems
beam transmission
photo-electric cells
facsimile
amplifiers
phonographs
measurements
receivers
therapeutics
television
counting, grading
musical instruments
traffic control
metering
machine control
electric recording
analysis
aviation
metallurgy
beacons, compasses
automatic processing
crime detection
geophysics



Chemistry of vacuum tubes

Sound-picture reproduction

The electron—its characteristics

Trends in receiving-set design

Industrial uses of electron tubes

A McGRAW-HILL PUBLICATION

JULY 1930

electronics

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Contents for July, 1930

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McGRAW-HILL PUBLISHING COMPANY INC., Tenth Ave. at 36th St., New York, N. Y.

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A McGRAW-HILL PUBLICATION

New York, July, 1930

The march of the electronic arts

sby-Grunow sues RCA ,30,000,000

suit for triple damages of $30,-0 filed June 25 at Kansas City, the Grigsby-Grunow Company hicago, radio-set manufacturer, s the existence of a vast illegal f radio patents created in violation Sherman Anti-Trust law.

suit names the Radio Corporaf America, the General Electric any, the Westinghouse Electric anufacturing Company and others. petition charges that the deit companies illegally created the pool and compelled payment of t $6,000,000 in royalties by the by-Grunow Company.

sets forth that under the "tube " contained in the license agreewhich the Chicago company re- from the defendants it was elled to buy radio tubes and was nted from engaging in the vacuum manufacturing business until the was declared illegal by the d States District Court of Dela- On this account, the petition es, the company was damaged in m of about $3,000,000 more, which other damages brings the total to 00,000.

ree times this amount is asked use the Clayton act entitles a plainn such cases to recover threefold.

✦

rnoff denies monopoly

id Sarnoff, president of the Radio poration of America, on June 30, : . . . . "The Radio Corporation es that it has, during the more than years of its existence, done anyg of which the Government should plain but that, on the contrary, what s done in obtaining rights under the patents of others was necessary for and has resulted in the establishment of modern radio which could not otherwise have lawfully been established nor brought to its present efficient condition. The development of radio was freed, not restrained.

"Further, the Radio Corporation has not attempted to monopolize these developments and patent rights, but has granted many licenses to others, with no price restrictions, thus enabling them to enter into direct competition with Radio Corporation and its subsidiaries in sales of tubes and broadcast receivers to the public."

✦

JOHN HAYS HAMMOND, JR.

who has applied a television system to airplanes in flight, so that the pilot may locate his position and see the landing field below him, despite fog

Sound picture conference in Paris

A hundred million dollars of invested capital is involved in the conference of leading executives of German and American electrical and motion-picture interests now in session in Paris. The series of patent suits now pending in the United States and Germany over sound equipment will be withdrawn if the present meeting results in an accord.

A settlement of the controversy will open German markets to American sound films, which have been closed to all American producers except Warner Bros., who recently acquired a substantial interest in the patents and licenses of the Tobis-Klangfilm, and Kuchenmeister group.

Official delegates are John E. Otterson of Electrical Research Products, Inc.; C. J. Ross, RCA-Photophone; J. C. Graham, representing Paramount; United Artists; Metro-Goldwyn-Mayer; Fox Films; Universal; Pathé; R-K-O; Educational and other American producing firms; Dr. Fritz Luschen, for Siemens & Halske; Dr. Emil Mayer, of the A.E.G. Company, Berlin, and Milton Diamond, also of this company. George E. Quigly, representing Warner Bros., also attended.

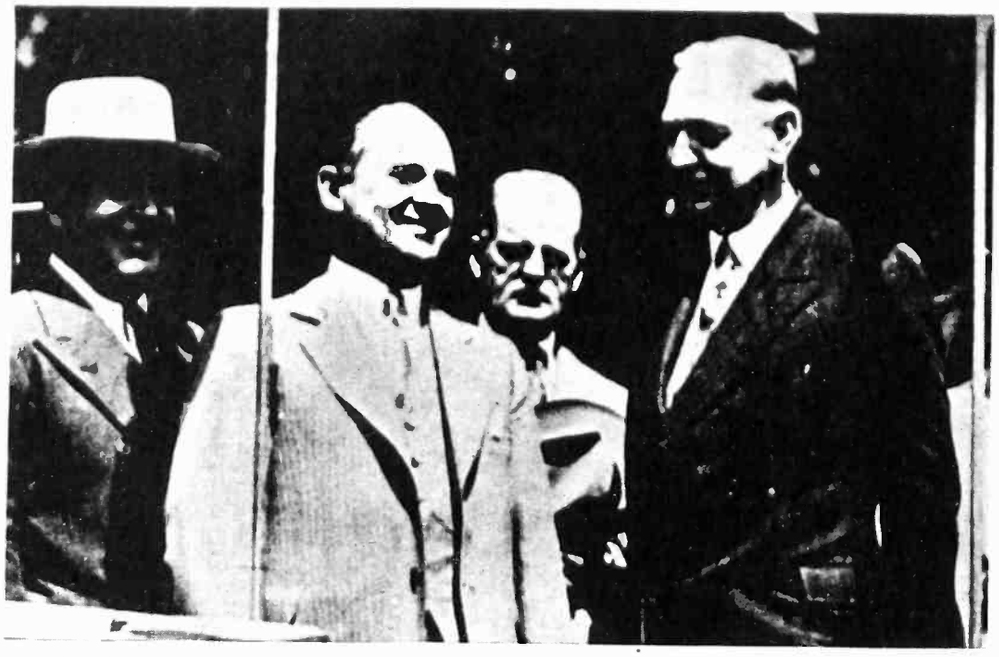
✦

Radio engineers at Toronto Aug. 18—21

The fifth annual convention of the Institute of Radio Engineers will be held at Toronto, Ontario, Canada, August 18 to 21, with headquarters in the King Edward Hotel. The engineering division of the Radio Manufacturers Association will convene at the same time.

The convention meetings and papers committee is under the chairmanship of

CLARK ANNOUNCES FOX FILM WILL SPEND $25,000,000



Harley L. Clark, (center) president of the General Theaters Equipment Company, and its subsidiary, the Fox Film Corporation, announces that the Fox Company will spend $25,000,000 during the coming year on the production of pictures and $5,000,000 additional in plant expansion

✦ ✦ ✦

K. S. Van Dyke and includes H. M. Turner, Dr. W. Wilson and H. P. Westman, Secretary of the Institute of Radio Engineers.

One of the features of the Toronto Convention will be the "component parts" exhibit, each exhibit being supervised by a technical representative.

A well-balanced program has been arranged and a series of local trips should prove most interesting.

✦

Development of airplane dependent on radio

The laison committee on aeronautic radio research has just reported to Clarence M. Young, Assistant Secretary of Commerce for Aeronautics, emphasizing the value of radio to aviation and the material progress of aeronautics that would be effected by research into several pertinent problems as well as the improvement of every use of radio in aviation.

The committee particularly recommended research in the fields of transmission data on medium high frequencies, radio receiver design, airplane direction finders, simultaneous reception of telephone and beacon service, altimeters, collision prevention, blind landing aids, characteristics of various types of fixed antennas, ice formation on antenna, ignition interference problems, including shielding, antenna design and location of receiver, spark plug shielding, standardization of shielding, drag of wind-driven generators and engine driven generator problems, including ripples and voltage variation.

Dill patent bill killed after Senate approval

The Dill bill, aimed chiefly at the Radio Corporation of America and companies affiliated with it, but with possible far-reaching effects in other business fields, was passed by the Senate June 3, but recalled shortly thereafter.

Essentially, the bill would suspend the right of the patentee to recover, in suits for patent infringement, if the defendant can show that the patentee is violating the anti-trust acts. It is a matter of considerable importance in trades which depend largely on patents.

Announcement of Senator Walsh of Massachusetts that reconsideration would be made, precludes House action, even in committee, and relegates the bill to the December session, where it will probably remain as open business.

✦

Ccllege offers summer school in electronics

Dr. Frederick B. Robinson, president of the College of the City of New York, announced June 11 a unique summer course in the "Theory and Operation of Vacuum Tubes," in the college laboratories by Prof. E. Gordon Taylor.

The novel course, scheduled for twelve weeks this summer, to aid technical followers of radio in learning about radio tube and photo-electric cell uses, is endowed by the National Union Radio Corporation. "A college like ours should do all in its power for the community by keeping abreast of technical developments in all fields," said President Robinson. "Some of the topics to be covered are: Detection by grid or plate rectification; inter-electrode capacities; power amplification; photo-electric cells with their application and thyratrons. Registration applications with the $10 fee should be sent to the registrar of the college."

✦

Earth's hottest spot, in tube, 900,000°

What is believed to be the hottest spot ever found on earth has been discovered by R. Tanberg of the Research Laboratory of the Westinghouse company on one of the metallic electrodes between which an electric arc is maintained inside a special type of vacuum tube. The ordinary electric arc between two carbon rods, as formerly used for street lighting, develops one of the hottest spots previously known, the tiny very bright spot or "crater" which forms at the tip of one of the carbon rods when the arc is working. This arc crater may be as hot as 10,000 degrees, Fahrenheit, almost as hot as the surface of the sun.

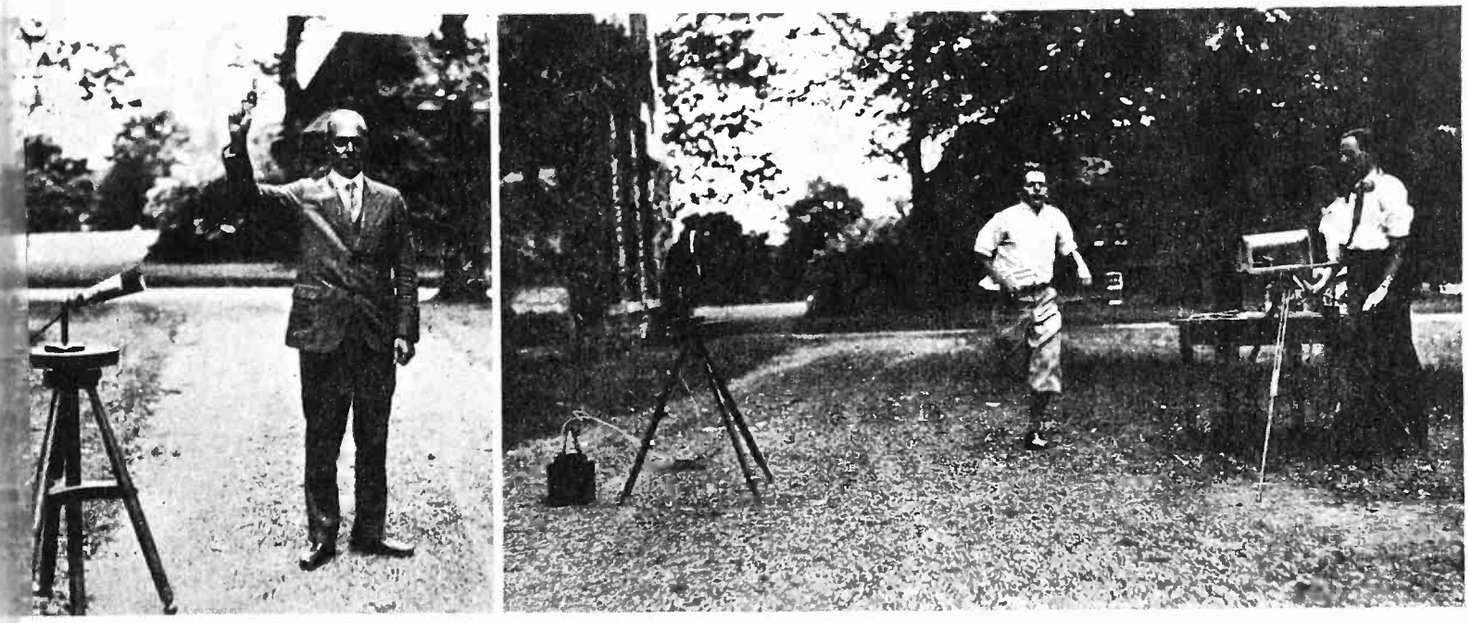
Mr. Tanberg's hot spot inside his vacuum tubes seems, however, far to transcend this; reaching, he concludes, a temperature not much below 900,000 degrees on the Fahrenheit scale. Mr. Tanberg's estimate is based not on direct measurement, of course, but on the observed behavior of gaseous atoms of metal vaporised from the electrodes.

✦

TEST SPEED OF LIGHT

Dr. A. A. Michelson, noted physicist seeking greater accuracy, will repeat his famous "speed-of-ether-waves" experiment in this evacuated pipe near Pasadena, Calif., during July

ELECTRON TUBES RECORD SPRINTERS' EXACT TIME



Eliminating the human element and timing races to within one one-hundredth of a second, is the feature of the new electrical clocking device perfected by two Haverford college students. The report of the starting pistol is picked up by a microphone and starts the electrical device, and when the runner crosses the finish line he intercepts a beam of light sent across the line. Thus a timing record of the race is made

✦ ✦ ✦

o-cell laid corner-stone of Westinghouse ratory

V. S. Rugg, vice-president, in e of engineering, placed a tiny corner-stone in position, delicate controlled by photo-cells operated oist that swung into place the corner-stone of the new West- use laboratories. The photo cell lled an intricate system of inter- relays, switches and motors. As odel block interrupted the light s, the versatile "electric-eye" con- , in synchronism, the various of the movements of the large on the building site, far removed the scene.

e new $2,000,000 laboratory, the t and tallest arc-welded struc- n the world, will contain 25 elab- y equipped laboratories for various hes of the electrical industry.

✦

el kitchen door opens n approached

-working hotel waiters, struggling gh kitchen doors with heavily trays, need no longer suffer izing efforts for the photo-electric has come to the rescue. An auto- c door-opener by which, without cious human effort, a door can be e to open swiftly and silently and lose in the same manner, was ex- ed at the convention of the Railway Supply Manufacturers Association, June 18 to 25, at Atlantic City, in the General Electric booth.

A ray of light focused on a photo-electric tube passed in front of the door. When this ray was interrupted it set a hydraulic door-opener to work, through the agency of a photo-electric relay. The tube and light were placed several feet from the door and, as a person approached, his body interrupted the light ray directed at the tube.

✦

Einstein, Compton, and Eddington discuss the electron

Pure science and electronics appeared heavily in the newspapers of the world during June as a result of several meetings of world-wide importance.

On June 16, Professor Albert Einstein bewildered 4,000 delegates to the World Power Conference, Berlin, Germany, by stating his latest views on space, time, matter, and ether in which he put forth his belief that "space had swallowed up both time and ether" and would finally become the only reality—to the relief of the assembled but unhearing delegates.

At a meeting of the American Physical Society, Ithaca, N. Y., June 21, Professor Arthur H. Compton, like Einstein a winner of the Nobel prize, gave the lie to theories which make of the atom a miniature solar system with concentric swarms of electrons hustling about it. Instead his new interpretation made the electrons appear as a cloud of discrete matter diffused throughout the sphere of the atom like raindrops.

Again at the World Power Conference on June 23, Sir Arthur Eddington tantalized his audience with visions of unlimited power existing—but as yet un-touchable—within the atom and in the motions of the electrons. His listeners were greatly impressed at Sir Arthur's statement that some day science would free this vast energy from the atom.

✦

DR. H. H. SHELDON

president-elect of the New York Electrical Society, who is professor of physics at New York University, demonstrates his new electronic "colorscope" for analyzing hues and matching samples even miles apart

ELECTRONIC TUBES IN

Industrial uses of vacuum-tube devices and circuits in chemical-process control and laboratory determinations

By H. M. PARTRIDGE, Ph.D.

New York University, New York City

WHEN an electrical discharge takes place in a gas under low pressure, three types of radiation are set free: anode rays, cathode rays, and X-rays. The first two are positive ions and negative electrons, respectively, and with their companion X-rays, become our servants in all electronic devices, from the new neon signs to the X-ray tube. The physical magnitude of these radiations will perhaps be appreciated when it is recalled that the heaviest positive ions are so light that a number equaling a billion times the total population of the earth, weighs only a milligram (1/28000 oz.).

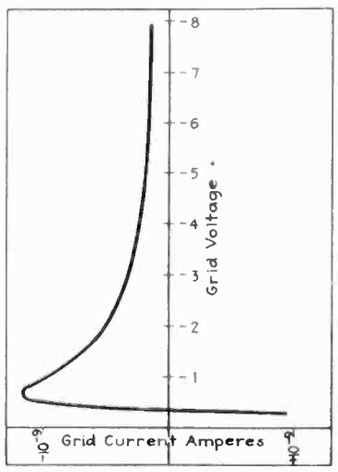


Fig. 1—Grid current-grid voltage characteristic

Among the many electronic devices which find use in chemistry are the positive-ray tube and attendant apparatus, by which we are able to show that elements having the same chemical properties may have a difference in mass. For example, argon, which is contained in most of our incandescent lamps and gas-filled photo-electric cells, has atomic weights of 40 and 36 respectively. Mercury, as we know it, is really a mixture of six slightly different elements.

The cathode-ray tube by showering high-velocity electrons into chemical substances in some instances causes polymerization or decomposition, and so may become very important as a method of preparing certain chemical compounds.

The X-ray tube lets us look into the arrangement of positive charges and electrons in the atom, and shows us the arrangement of atoms in a crystal and, in the light of recent work, seems to establish an orderly arrangement in certain solutions.

The Braun tube (cathode-ray oscillograph) enables us to photograph the course of a reaction which is too fast to be followed by the eye, and permits the constant checking of audio frequency wave form required in many precise measurements on solutions and gases.

Neon tubes and their modifications serve as sources of visible radiation of definite frequencies for the carrying out of photo-chemical reactions, as a means of supplying and checking stroboscopically audible frequencies for conductivity and dielectric constant measurements

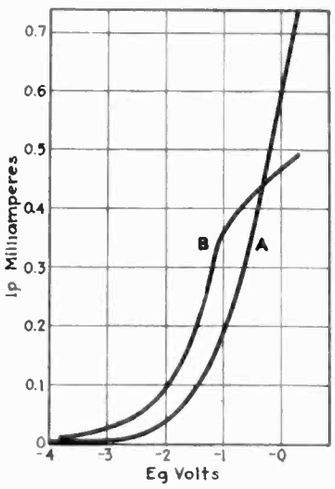


Fig. 2—Mutual conductance characteristic

and as a means of indicat light intensities when u with the photo-electric

Other gas-discharge lays, like the grid-glow t and the thyratron, find v ous applications in the re lation of light, heat power in chemical proces

Diodes to pentodes

Probably the device wh has the greatest poten possibilities is the vacu tube of the radio type. models, from the diode the pentode and from "peanut" tube to the tra mitting valve, find uses in the chemical laboratory. Au oscillators furnish the alternating potential for measu ments of conductivity and dielectric constants of liq and gases. Bridge currents in conductivity and capa measurements may be amplified, rectified and read o d.c. milliammeter, thus substituting a visual method the audible one.

Viscosity measurements in solutions and in oils opaque to follow a dropping steel ball in them, are ried out by surrounding the measuring vessel with a grid coil of a vacuum-tube oscillator. As the ball pa through each coil, a click is heard in the headphone

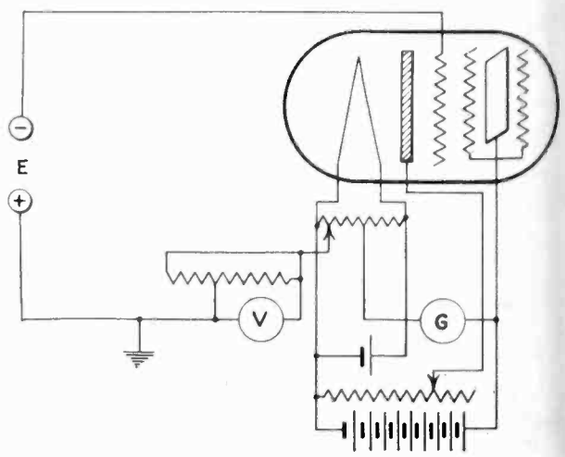
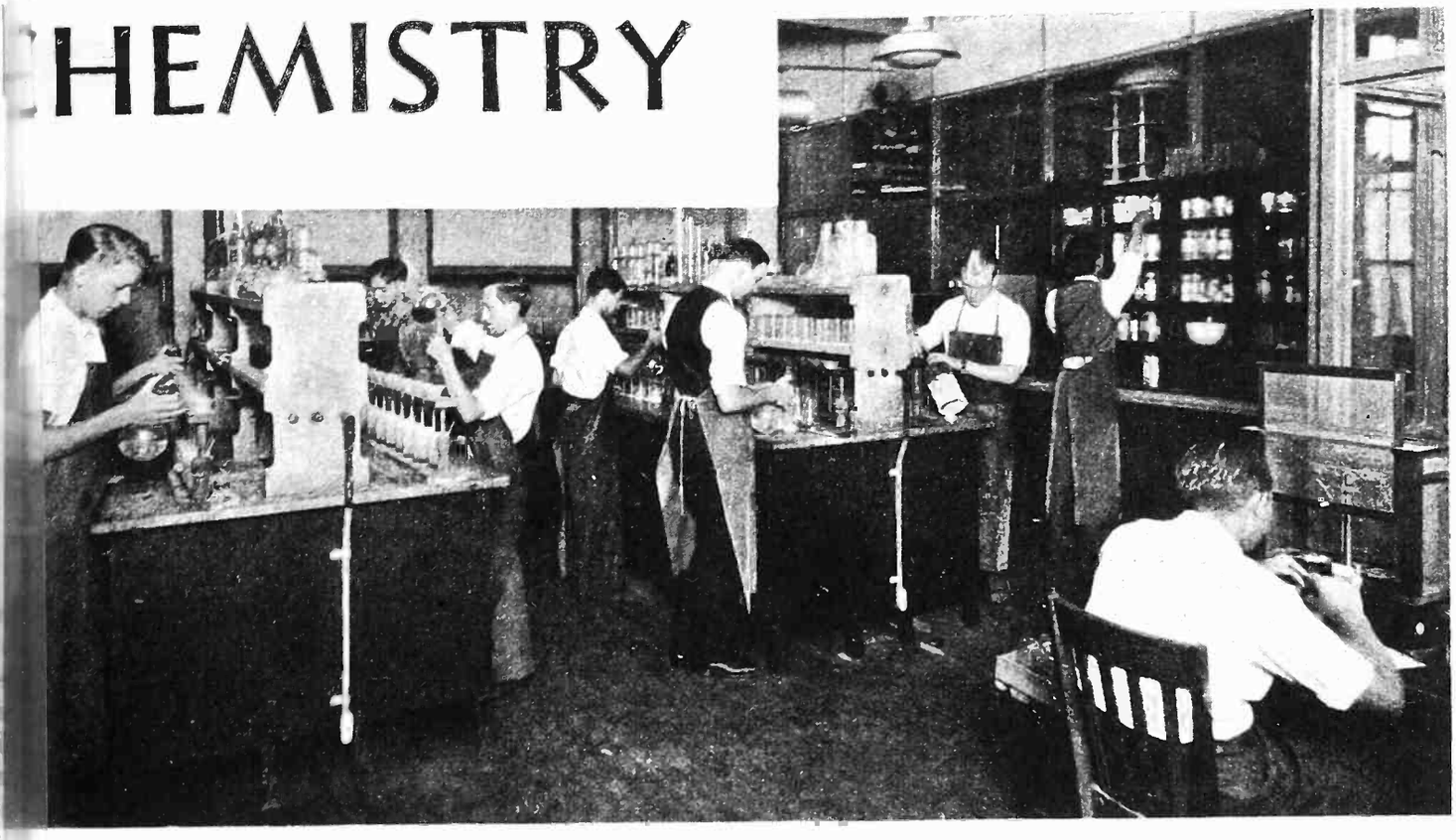


Fig. 3—Use of A.C. tetrode as "slide-back" voltmeter

CHEMISTRY



The vacuum tube and photo-cell are becoming widely useful chemists' tools

te circuit. The viscosity of the liquid is a function the time between clicks and of the physical characteristics of the ball.

Electromotive force measurements play an extremely important part in modern methods of analysis, in solubility measurements and in determining activity values. In many instances the use of the conventional Poggendorf system causes too large a current drain on the cell to be measured, before the balance condition is reached. As little as 10^{-6} amperes is often disastrous to the usefulness of the result. In addition, many of the cells have extremely high resistance and a galvanometer cannot be used directly in the measuring circuit.

Even the vacuum-tube potentiometer must fulfill conditions not ordinarily demanded. Let us take a specific example—the glass indicator electrode. We ordinarily think of glass as an excellent insulator, yet if we select the proper type and blow it into a thin bulb the glass becomes conducting to a small extent when both walls are covered with aqueous solutions of acids, alkalies or salts. Furthermore, if a solution of constant acidity is placed within the bulb and the whole immersed in another solution, a potential will be set up between glass electrode and solution depending on the acidity of the second solution. An inert reference electrode, such as the calomel cell, forms the other half cell and we now have a cell with resistance which may vary from a few tenths of a megohm to several hundred megohms and whose E.M.F. depends upon the acidity of the solution contained in it. The total E.M.F. of the two half cells may be as low as 100 millivolts. This type of cell is extremely important as it is not easily "poisoned" and permits acidity measurements in the presence of strong oxidizing agents which are often necessary.

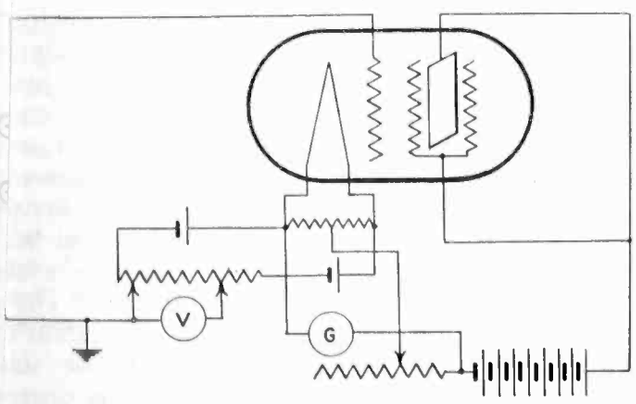


Fig. 4—D.C. screen-grid tube used as triode voltmeter

To illustrate the importance of accuracy in these measurements in biological studies it is interesting to note that the acid content of the human blood (Mitchell, General Physiology) must lie between the close limits 7.25-7.40 acidity (technically, pH) units. A slight change beyond either would cause instant illness or death.

Acidity analysis in industrial processes

Other important applications of acidity measurements include as great a variety of processes as the fermentation industries, electroplating, tanning, soap manufacture, industrial water supplies and crystallography.

In many of these cases, the hydrogen, quinhydrone, and metallic electrodes cannot be used because of rapid poisoning. The problem, then is to measure the E.M.F. of a cell which will range from 100 to 1,000 millivolts and whose resistance we shall assume may be as high as 100 megohms. The IR drop caused by unwanted current must be less than that required to give an error of 0.1 millivolt. According to Ohm's law,

$$I = \frac{E}{R} = \frac{10^{-4}}{10^{8}} = 10^{-12}.$$

The maximum permissible current is then 10^{-12} amperes.

Since the potential is to be measured in the grid circuit and indicated in the plate circuit by means of a

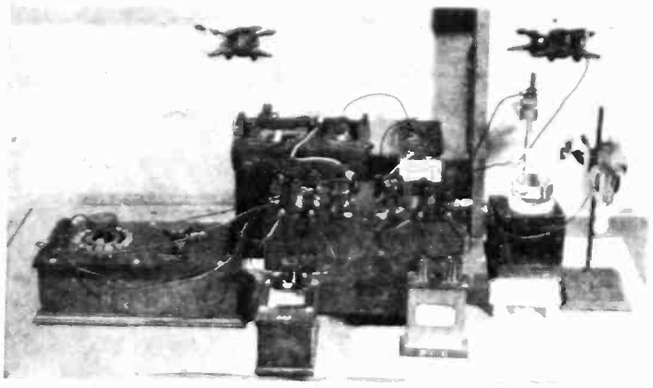


Fig. 5—Set-up of tube apparatus in chemical laboratory

balanced micro-ammeter or galvanometer let us look at the current characteristics of the average low-impedance receiving tube. Fig. 1 shows such a curve. The point at which Ig is truly zero is the free grid potential, and varies from about —0.1v. to —1.5v. depending on the design and "hardness" of the tube. Since we must have a high grid-to-filament and grid-to-plate resistance, the tetrode or pentode with control-grid connection protruding through the top of the envelope will give less leakage trouble.

Both a.c. and d.c. models of the tetrode have been used with success. To improve the mutual conductance, the tube is used as a triode by connecting screen grid and plate and to insure more stable operation, low plate and filament potentials are employed. Curve A, Fig. 2 shows a typical mutual-conductance curve under the conditions mentioned. If now an external resistance of a few hundred megohms is placed in the grid circuit, the mutual conductance curve is displaced to B. Curve B crosses A at the value of Eg corresponding to the "floating potential." As the value of the series grid resistance is made increasingly large the slope of curve B approaches zero where it crosses A. A zero slope, of course, means zero sensitivity. The necessity for operating at free grid potential at once limits us to some form of "slide back" method. If the circuit can be made compensating or partially compensating without undue complication so much the better.

Fig. 3 shows the scheme adopted when using the tetrode and Fig. 4, for the d.c. type. (Circuits employing more than one tube either as additional amplifi in a bridge arrangement are purposely omitted.) illustrates apparatus designed by the author emp the circuit of Fig. 3. The heater must be operat a storage cell and has the disadvantage of req nearly 1.5 amperes at 2 volts. In place of voltmet a student-type potentiometer (extreme left) has substituted to insure better precision. Maximum bility of operation is theoretically obtained (Mul Razek, J.O.S.A., 1929) when the relationship of ment, grid and plate potentials is such that the t operated at the point where the tangent to the voltage-plate current curve passes through the orig shown in Fig. 6. The high grid-circuit resistance n sitates shielding from sources of electrostatic indu It is obvious that it is nearly impossible to satisf theoretical demands for maximum sensitivity and bility (several of which have not been considered) Figs. 3 and 4 represent an attempt to compromise practicability.

In addition to being useful as a voltmeter, the vac tube is rather surprisingly sensitive for measuring s currents. It is stated that a tube of special constru

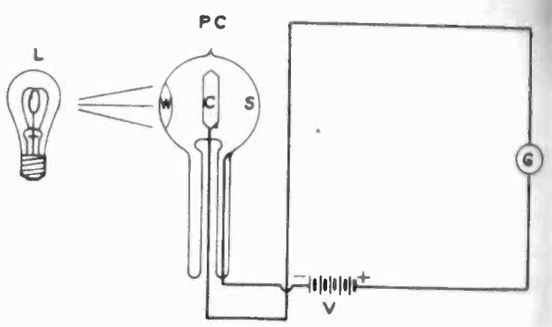


Fig. 8—Typical circuit employing photo-electric cell as measurer of light intensity

is capable of measuring 10^{-17} amperes—a flow of 63 electrons per second. If we were to measure current with a silver coulomb meter we should have wait eight hundred million years for the deposition of ounce of silver. Nottingham (J. Franklin Inst., 19 has shown that with a single 201-A tube, by using a v high grid leak and operating on the negative slope of grid voltage-grid current curve, current amplification excess of twelve million fold may be obtained and at grid potential one hundred thousand fold current g may be realized.

The applications of the vacuum tube to the measu ment of small currents are widespread in devices ploying the photo-electric cell for chemical analysis control. In the case of acidity measurements just c lined we have in addition to potentiometric meth those involving the change in color of a class of orga substances known as indicators. Indicators are of general types—one-color indicators, which involve change in transmission of light of one spectral band color and two-color indicators, which involve a sim change in two colors with change in acidity. The i cator methyl orange, for instance, in acid solution tra mits red light preferentially and in alkaline solut shows a preference for yellow light. Varying degree acidity between these two colors give the eye a sensa of different shades of orange. This is not due to

[Continued on page 192]

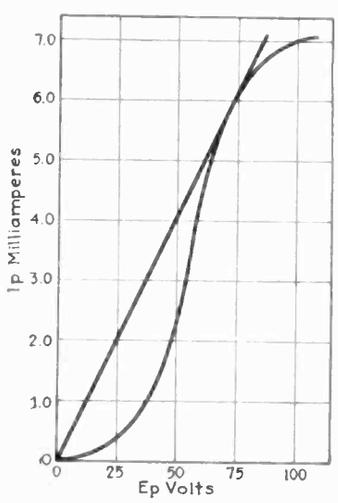


Fig. 6—Marking point of maximum stability of operation of vacuum tube

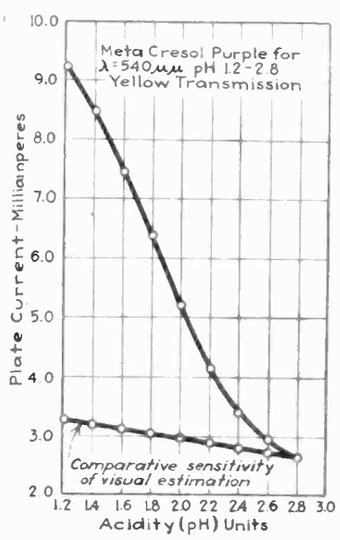
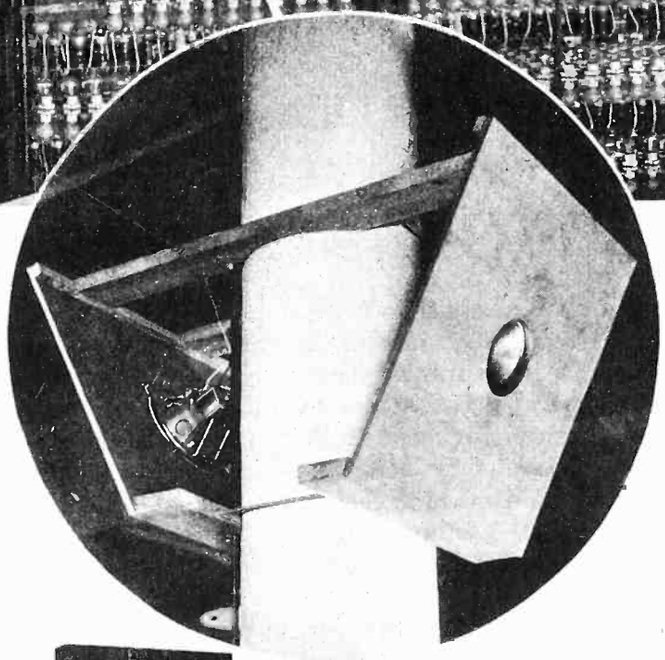


Fig. 7 — Increase in sensitivity of titration by using photo-electric cell

mplifier speakers in tory workrooms



Above is shown the method of mounting pairs of loudspeakers on the factory columns throughout a large workroom

Radio programs and phonograph records can be reproduced for the entertainment of factory workers, and the "big boss" can address all hands without even leaving his desk, by using an amplifier system like that illustrated. Morale is improved, and spoilage is decreased, report managers who have tried it

At left is the control board and phonograph pick-up as installed in the Newark, N. J., Radiotron factory. The system employs the standard centralized circuit for public-address systems

A multi-range vacuum tube voltmeter

By LEONARD TULAUSKAS
United Air Cleaner Corp.

A THERMIONIC voltmeter is indispensable to every radio or audio laboratory, yet there seems to be little uniformity among the types in general use. Too many voltmeters of this sort do not retain their calibration for any length of time, while others are subject to frequency errors. Many require expensive equipment as adjuncts to their operation and the majority use a number of bulky batteries. Still others require a skilled operator for the exact manipulation of a number of controls.

It is the purpose of this article to describe a vacuum tube voltmeter which does not have the limitations of other types.

It is extremely compact; its overall dimensions are $7\frac{3}{4}$ inches long, 6 inches wide, and 6 inches high. Only one 45-volt B battery is required although any source of continuous current capable of supplying 50 to 60 milliamperes at 38 to 50 volts will be found equally satisfactory. It is accurate at both radio and audio frequencies; no corrections are required. It covers a relatively large range—up to twelve volts peak—an only one main adjustment.

▼

Many engineers have used vacuum tube voltmeters, in spite of the fact that they do not cover a very wide range and are not very constant in calibration. The author, a radio engineer, describes a thermionic voltmeter that is stable, useful at both radio and audio frequencies, and covers a wide voltage range.

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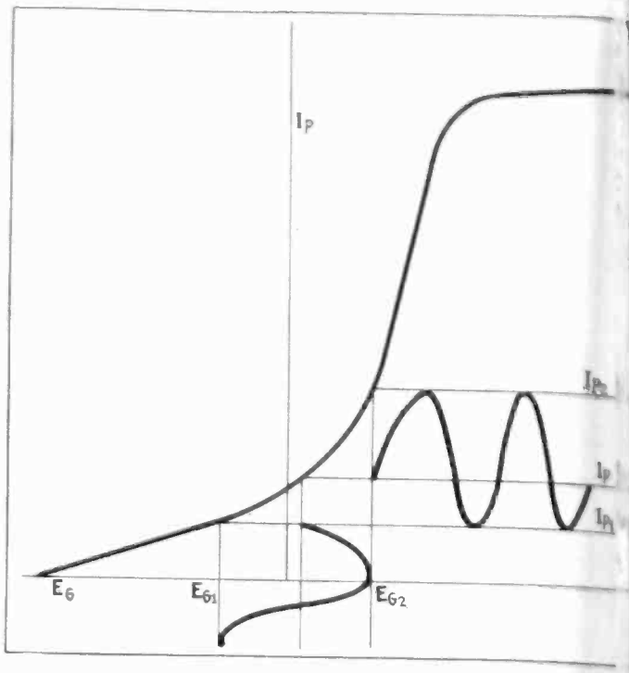

Fig. 1. Using a curved part of the plate current curve results in a change in the d.c. plate current

The theory involved is very simple. Conside plate current-grid voltage static characteristic o so-called "all-purpose" triode. This is of the form s in Fig. 1. If the grid voltage is adjusted to a where the curvature of the characteristic changes tube will act as a rectifier. This action can occ either the upper or lower bend of the curve.

In Fig. 1, the grid of the tube is biased so that o tion results on the lower bend. The impressed a shown as varying from E_{g1} to E_{g2} while the plate rent varies from I_{p1} to I_{p2}, correspondingly. A initial plate current was I_p, and the variations abov below that value are not equal, the result is an effe increase in plate current which would be shown direct current milliammeter in the plate circuit. ously, the plate current change will be greater increased impressed e.m.f. and vice versa.

It is difficult to utilize this principle directly a plate current change is small, requiring the use microammeter. As the initial plate current is lar proportion to its variation, some means must be emp to utilize the variation only. This is done, usuall some form of bucking battery whereby the steady current is balanced out and the increase over that operates a microammeter. Unfortunately, such a d is subject to "drift"; i.e., variation of the zero point is a scheme which is widely used, however, and in of all its faults is capable of fair results in experie hands.

Amplifier voltmeter combination

In a previous paragraph, it was seen that the rec action caused a change in plate current. If a d current amplifier was connected to the output o rectifier, the output of the amplifier would vary in portion to the amplitude of the a.c. impressed o rectifier grid. Only the *variation* in plate curre utilized as the grid bias on the amplifier compen the steady value rectifier plate current which ten reduce the amplifier grid bias. Furthermore, the v tions are amplified many times so a meter of lower

ay be employed. Such an arrangement is shown
2.

plate by-pass condenser in the rectifier circuit is ssential towards its proper operation because the mponent of the pulsating plate current increases s of the amplifier tube while the positive a.c. peaks se it. Elimination of the a.c. will give a greater urrent change.

grid and plate batteries of the tubes must be of alues that the input tube operates on the lower f its grid voltage-plate current characteristic, while tput tube operates along the linear part of the is an amplifier only.

ie bias on the first tube is increased beyond the where the plate current becomes zero, any further e in bias will not change the reading of the mmeter as there is no change in the input circuit amplifier tube. This suggests the possibility of ng the range of the meter by adjusting the bias he value required for cut-off. A calibration curve a meter would appear on the order of that shown 3. Investigation reveals that these curves are allel to one another. This is a very desirable ion as will be shown later.

rring to Fig. 2 again, it is apparent that if the at consumption of the tubes were small, one bat- uld be used to supply B and C voltages as well as at power. The 199 type tube requires only 60 peres for its successful operation and will give tory operation with as little as 50 milliamperes

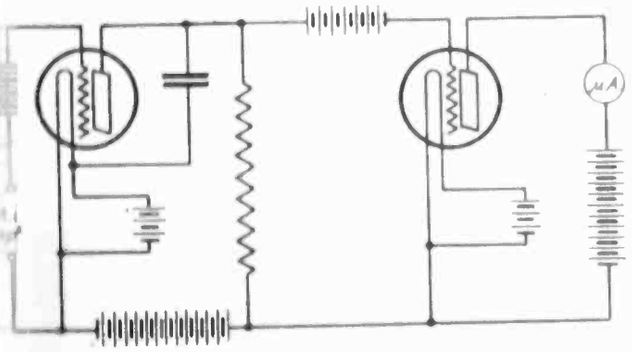

Fig. 2. Theoretical circuit of the amplifier-voltmeter

gh the filament. For that reason, two of these were used in the modified circuit as shown in .

Preliminary calibration of the voltmeter

calibrate the voltmeter and determine the values of ances to be used the tubes should be connected as g. 4. To the input circuit must be connected a e of a.c. which may be varied from zero to about lts and a voltmeter to indicate the total impressed ge on the first grid. The resistors may be made decade resistance boxes or small variable resistors. ie latter case, their resistance must be determined a bridge when the measurements are completed. preliminary adjustment, it is advisable to use the es of resistances given in Fig. 4 which represents the circuit. The rectifier load resistor is not critical; ay be any value from 4 to 10 megohms. A milliam- er is placed in series with the 45-volt B battery and ng all the adjustments care must be taken that the ent in that circuit never exceeds 60 milliamperes.

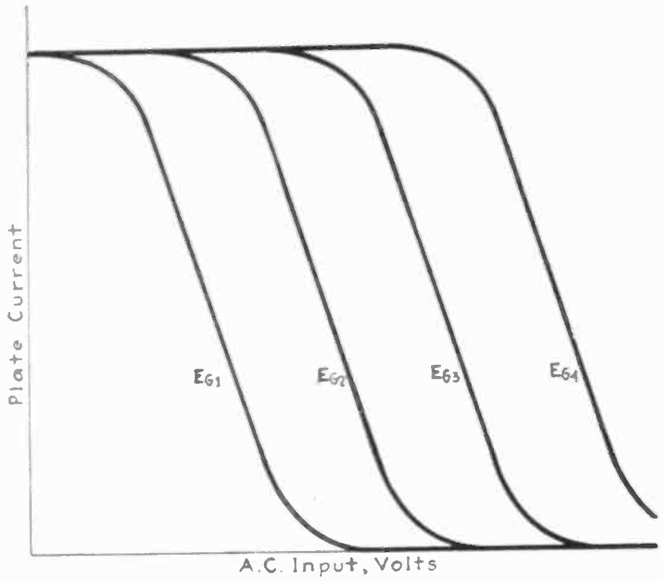

Fig. 3. Series of calibration curves for various values of grid bias

The resistors are then adjusted so that the total useful voltage at the tubes is 37 volts which represents the voltage at which a 45 volt B battery requires replacement. Keeping this voltage about the same, the B and C voltage drops are adjusted so that with zero input the microammeter indicates full scale while a variation of about one volt a. c. input voltage reduces the reading to zero practically. When the proper resistances to accomplish this have been found, their values should be noted and the tubes to be used with them labeled. In obtaining the above approximate calibration, make sure that the input tube is operating below or at the cut-off value.

Choice of apparatus

After the proper resistances have been determined, they may be made up in permanent form; as they are by-passed they need not be non-reactive. Of the parts to be purchased the writer recommends the Weston Model 301 200 microammeter or a similar instrument and the General Radio and Frost potentiometers.

The photographs show several views of the voltmeter and the construction and mounting of the various parts.

Construction notes

The resistors may be wound on $\frac{1}{8}$ inch diameter bakelite tubing of different lengths to accommodate the various resistance values required. Resistance wire Advance No. 30, D.S.C. is desirable from electrical and mechanical standpoints.

The adjusting rheostat must be insulated from the panel if the latter is metal, as is advisable, while the

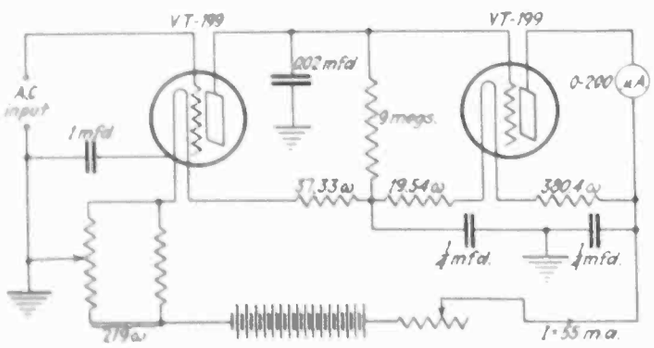

Fig. 4. Circuit giving proper values of resistances, etc.

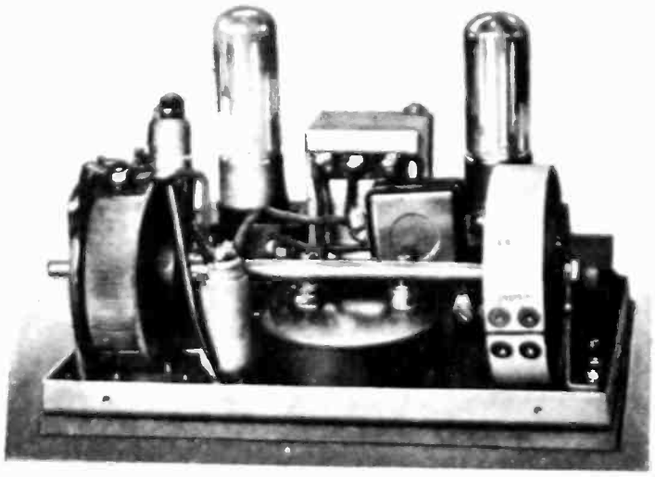

Fig. 5. Internal view of completed instrument

short-circuiting switch may be mounted directly on it and grounded.

In wiring the voltmeter, it is advisable to mount the resistors upon a tube shelf with the grid leak type resistor mounted underneath the shelf and the entire shelf unit wired as completely as possible. Then the various parts may be mounted on the sub-panel and the panel fastened to it by means of instrument mounting screws. In the writer's instrument the range dial opening is covered by a thin piece of clear celluloid with a black hairline across it. This indicator may be mounted by slipping it between the panel and sub-panel and tightening the screws that hold the potentiometer shaft bracket. This sub-panel assembly may then be wired, the tube shelf attached, and the remaining wiring completed. The lead from the grid binding post to the tube socket should be made very short.

Final calibration of the instrument

After the thermionic voltmeter is fully assembled and wired, it may be mounted in a brass case and is ready for calibration. Any source of a.c. of known wave form is suitable for this purpose. An accurate a.c. voltmeter to be used may be the Weston Model 412 Thermovoltmeter having a range of 0-1-5-10-50 volts. This meter is accurate up to 3,000 cycles per second. The voltage divider may consist of several decade resistance boxes or, preferably, the General Radio type 554 voltage divider.

When all the apparatus has been properly connected, the range control is adjusted to maximum bias and the battery rheostat adjusted so the microammeter indicates full scale with the input circuit closed or short-circuited. The input switch is then opened and the voltage divider adjusted to various values with a constant input voltage applied to it. The reading of the microammeter is plotted against r.m.s. input volts. The calibration curve obtained will be fairly straight from about 180 to 20 microamperes. Suppose, for example, that 10 peak volts were required for a reading of 180 microamperes, and 11.5 peak volts for a reading of 20 microamperes. Then the calibration may be carried out in 1.5 peak volt increments. The input for 100 microamperes is, say, 10.8 peak volts. The input is then adjusted to 10.8 — 1.5 = 9.3 peak volts and the range control adjusted so that the deflection is 100 microamperes again. In the same manner the other points at intervals of 1.5 peak volts are determined. When the lowest range is reached, it is very likely that endeavoring to use a 1.5-volt incre to reach it will allow the detector to operate above cu This condition would affect the entire calibration at range and must not be permitted to occur. In suc case the increment from the previous range to the l range must be some decimal part of the usual 1.5- value and noted as such. As mentioned previously, eration above cut-off is indicated by a decrease in microammeter deflection. While the original calibra curve was made from 10 to 11.5 peak volts, conform to our previous assumption, if the total increments the dial add to nine peak volts, the calibration curve m be changed to 10 — 9 = 1, to 11.5 — 9 = 2.5 peak v range, and the increments marked as positive on the d

The calibration should be made at 2,000 or 3,000 cy if sufficient output can be obtained at those frequenc It may be checked at 60 cycles and at radio frequen and will be found substantially the same in both cases

Use of voltmeter at radio frequencies

If this thermionic voltmeter is to be used at ra frequencies a great deal, it is advisable to determine effect on the circuit in which it is placed. It has inductance but has a small input capacity and high in resistance. Both may be measured by adjusting a tun circuit to resonance with a standard variable air co denser and then connecting the thermionic voltme across the condenser and retuning the circuit with t variable condenser. The difference between the tw capacity readings is the capacity of the voltmeter. T same circuit may be measured for high frequency resi ance without the voltmeter and after the voltmeter h been added to the circuit. The difference between t two resistance values is the series resistance reflect into the resonant circuit by the voltmeter. In most ca this will be found so small as to be negligible.

Fig. 6. External view of amplifier-voltmeter

The first thermionic voltmeter of this type was co structed some time ago and its calibration checked frequent intervals and found to remain constant. consideration of the factors affecting the calibrati would indicate that it may be considered permanent f at least 1,000 hours. This means that recalibration, a new tubes, are not necessary for more than a year in laboratory doing considerable work requiring such meter while in the average radio laboratory where t demands are more moderate, the calibration will rem accurate for several years.

ery short

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ome possibilities of
our-element tubes
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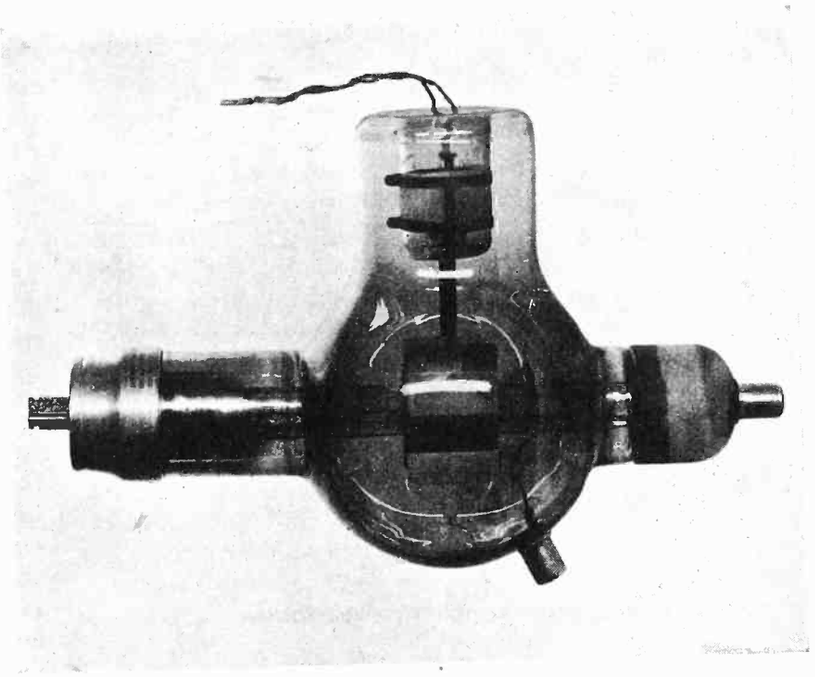


Source of high-frequency oscillations

A. B. PAGE*

OBABLY the occasion will never arise when one ill want to heat, or boil, a bottle of beer in a haystack—but it is likely there are some real ns where it would be desirable to heat some object t heating the surroundings—without burning up y. And when that problem is brought to the on of the research engineer he will be able to mend the kind of heating that will accomplish such . It all resulted from Dr. Willis R. Whitney, r of the General Electric research laboratory, ering how a gall fly makes a gall. The gall-fly igations led to the development of a new type of employing high-frequency vacuum tubes.

Whitney believes in hobbies, and among his hob- re insects. The golden-rod on his farm is host e early life of a small fly, the grub of which causes e, round swelling, or gall, in the stalk of the plant. gall, we are informed by the dictionary, is a swelling crescence of the tissues of plants resulting from tacks of certain parasites, which cause an abnormal sometimes very extraordinary proliferation of the of the host plant. The insect punctures the bark lays an egg in the wound, and the larva lives in feeds on the gall.

t just what causes the swelling? One theory is when the egg is laid the insect injects some acid, as the formic acid of the ants, which causes the ts to swell so appreciably at that point. Still another ry is that certain bacteria or moulds are injected into plant when the egg is laid. But, reasoned Dr. itney, could it not be possible that the swelling lts from the local heating of the plant at that point the growing grub within it, especially since it is wn that the growth of plants is accelerated by heat?

And so experiments to grow artificial galls on plant stems by means of localized heat were undertaken.

Experiments were conducted with an induction furnace, an electric heater using alternating current of from 300,000 to 500,000 cycles per second. Such a furnace, really the few turns of the low-voltage side of a transformer, will quickly heat and melt metals placed within the coil, but will not affect electrical non-conductors.

It was decided to see if galls could be grown by means of artificial grubs of steel, heated by induction; so tiny pieces of needle points were inserted in the stalks of healthy golden-rod plants which had been potted and taken into the laboratory. The coils of the small induction furnaces were placed over the stalks at the points where the needle points had been inserted. The tiny bits of steel were heated by the induction furnaces, but only in one case did a gall develop.

In that one case it was not the usual large and circular gall, but was long, thin and irregular—but it was a gall, at any rate. It seemed as though success

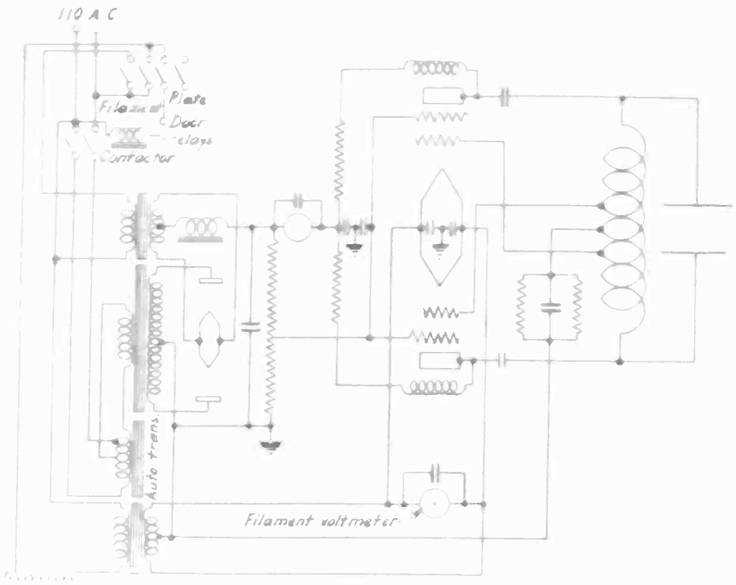
▼

In these experiments with high-frequency fields

Mice lost their tails
Cold feet were heated
Insects were killed
Metals were melted
Rats responded to insensible heat
Moisture was driven out of porcelain
Hibernating fruit flies revived, despite zero temperatures

▲

*Research Laboratory, General Electric Company, Schenectady, N. Y.



Wiring design of high-frequency heater

was being attained, but then a new kind of grub was found within the gall. The coil, by chance, had been placed right over the spot where a different kind of gall fly had laid an egg. The experiments to produce galls with steel grubs had not been successful, but interest in the possibilities of high frequency had been raised.

Boll weevils and fruit flies

Shortly after the gall-fly experiments were conducted, the governemnt inquired of Dr. Whitney if radio waves could be used in fighting the boll weevil. Weevils were not available at Schenectady, but Drosophila—the biologists' friend, the fruit-fly—was immediately available and was made the subject of the investigation.

The induction furnace, with a maximum of 500,000 cycles, was discarded in favor of an induction coil through which very high frequencies (ten to thirty million) were being passed. It was found that the insects could be heated easily when subjected to the short waves, and that they could be killed instantly in intense fields. It was found that a more uniform field could be obtained between condenser plates, and that the temperature could be controlled easily when the insects were kept in glass tubes between and out of contact with the condenser plates.

Fruit flies could be kept in glass tubes in this short-wave field and made to hibernate by passing ice-cold air over them. Then, by a change of field intensity, the flies, still in the ice-cold air, would warm up internally and fly about—they had become their own furnaces.

While it was found that the flies could be killed by the short waves, the method did not seem immediately practicable for development as a means of combating the boll weevil.

A warm nest

Experiments with the same high-frequency heater were then conducted with another friend of the biologist —the white rat. Given a long glass tube as its home, the rat could build its cotton-waste nest either out in the open or back within the heating coil. The field intensity was maintained at just enough to elevate the rat's body temperature slightly, and the animal elected to construct its home in the heated area.

In another part of the laboratory experiments short waves were being conducted by radio engi They noticed that their feet heated rapidly, partic when they might be standing on metal plates. Th pany physician found that, when working with a to-eight-kilowatt generator producing 20- to 30-m waves, the blood temperature was slowly raised when men were in close proximity to the equipment.

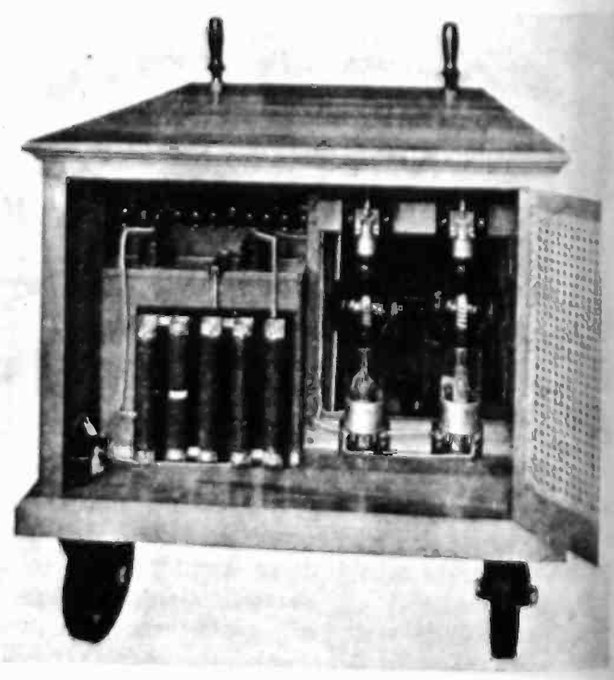
This information fitted in well with the experim which had been conducted previously with induct coils, so one of the new tubes was used in further exp ments with rats.

Dehydration of tails and porcelain

A mouse kept between condenser plates connected w the new short-wave tube was subjected to increas field intensities, with consequent increases in body te perature. No discomfort seemed to have been exp enced by the rodent until the field intensity was decide increased. And then the mouse lost its tail, but app ently without discomfort. It was simply a case dehydration—the short waves had driven out the mo ture, the tail had shriveled and dropped away.

The experiments conducted with this tube in the p duction of artificial fevers have been previously descri in *Electronics* ("Producing artificial fevers by sh radio waves," Charles M. Carpenter and Albert B. Pa *Electronics*, May, 1930).

The fever investigations have not been the only on conducted with the new equipment, however. The deh dration of the mouse's tail led to work in the curing raw porcelain. Before moulded porcelain can be fir and baked it is necessary to dry it thoroughly. Th has always been a time-consuming job, especially in t case of thick pieces. It has been easy enough to d the exterior, but the moisture within the mass has alwa offered difficulties. The short-wave apparatus has t peculiar property of heating objects from the inside ou so that it becomes possible to dry porcelain thoroughly



High-frequency capacitors and tubes

minutes. While the work has been done in the tory, the process is one that still needs engineering esign before it can become commercial.

Pliotron PR-861

tube used in the investigations is the General c Pliotron PR-861, a four-electrode tube of the grid type. It has a nominal output rating of 500 and is especially adapted for use at the higher ncies. The filament, grid and plate are supported parate stems with the leads brought out at seals, thus insuring high insulation and low elec- ic capacities between electrodes. The filament is ed tungsten in the shape of a double helix, sup- from a center rod and requiring no tension s. The grid and plate are cylindrical; the plate wings for dissipation of heat.

fourth electrode, the screen grid, consists of a nesh or winding placed between the control grid ate and extends the ight of the tube. It ported by suitable n on the filament ntrol-grid stems. function of this d grid is to provide ctrostatic shield be- the plate and the l grid. The poten- the screen grid is onstant, and varia- in potential of the have practically no e in the control-grid ial or on the elec- tic field at the fila- Therefore there be practically no ack through the tube the plate circuit. In frequency amplifier ts this reduces the sity for any neutral- n to prevent feed- and oscillation.

e high-frequency r is designed to pro- a means of heating rials in a high fre- y (10,000 kilocy- electrostatic field, a gross output of the oscillating tubes of about one att. The apparatus is enclosed within a case about feet high, three feet wide and six feet long, mounted heels so as to be portable. It is like a short-wave transmitter, with the exception that the energy is ntrated between two condenser plates instead of be- directed from an aerial. In one model these condenser s are mounted atop the case; in another model the s are on a separate adjustable stand. The controls meters are on the front panel of the case.

he set is operated from 105-125-volt, 60- or 25-cycle, nating-current mains, and at normal conditions of ation draws a current of 30 amperes. The power t to the set is, then, approximately three kilowatts. n oil-immersed transformer having a 7,000-volt ndary and feeding a full-wave rectifier forms the 0-volt direct-current supply for the oscillator. This transformer has a separate winding operating the filaments of the rectifier tubes. An autotransformer is connected in the primary of the high-voltage transformer to provide plate-voltage regulation.

The rectifier consists of two half-wave hot-cathode mercury-vapor tubes in conjunction with a filter. A condenser is connected directly across the high-voltage direct-current supply. Since this condenser provides the peak currents drawn by the oscillator, the full plate voltage swing is utilized across the heater plates.

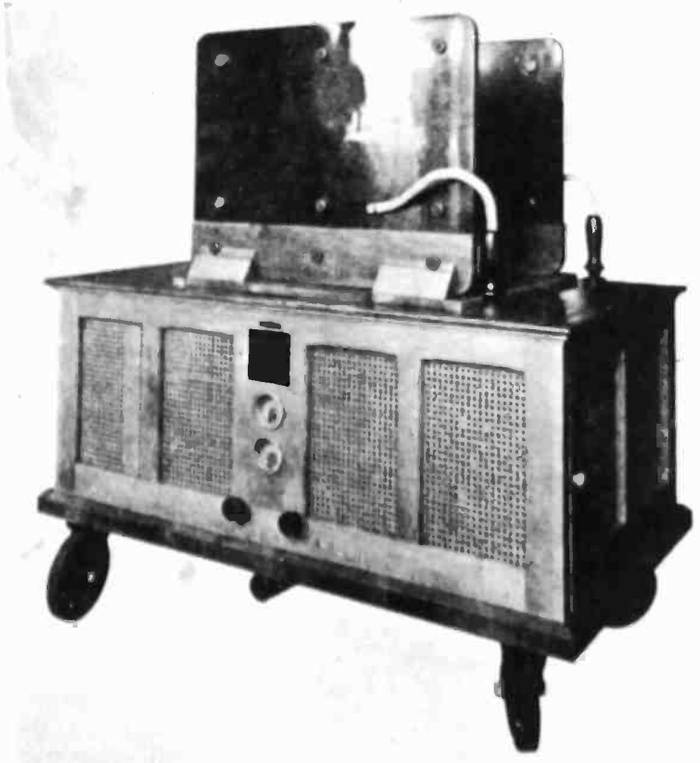
The screen-grid voltage for the two PR-861 tubes is supplied from a potentiometer system across the 3,000-volt direct-current supply. (This voltage, approximately 500 volts, is not critical.)

Filament power for the oscillator tubes is supplied from a separate transformer under the platform. The filaments for the rectifier and oscillator tubes are turned on by means of a switch on the control panel.

An adjustable rheostat in the primary of the filament transformer provides filament voltage control for the oscillator tubes. A filament voltmeter indicates the voltage. This adjustment is used to compensate for voltage drop in the lead line which would normally cause the oscillator tube filaments to run at too low a voltage.

An ammeter is connected in series with the high-voltage supply to indicate the total plate current of the oscillator. This ammeter is protected by a glass cover since it is at high potential.

A shunt-feed *Mesny push-pull* circuit operating over a frequency range of 9,000 to 12,000 kilocycles is used as the oscillator circuit. Best operation is obtained at about 10,000 kilocycles. In this circuit the heater plates are in parallel with the oscillator tank coil. The high-voltage direct current is blocked from the heater plates by means of two 6,000-volt condensers.



High-frequency heater. Front view showing electrodes in position and connected through cables and plugs

The entire oscillator and power supply, with the exception of the heater plates, are enclosed in a hardwood framework, and the operator is at all times protected from any high-voltage current. In case the doors are opened during operation, relays are provided to shut down the set automatically.

The heater plates are insulated by two hard rubber sheets, one on each side of the aluminum plate. However, care must be exercised to prevent accidental contact with these plates or the leads to them. They are at high radio-frequency potential, and burn-producing arcs will be caused by conductors touching them. Danger is avoided by turning the plate switch off before any materials are placed between the heater plates on the top of the portable device.

Engineering trends in receiving sets at Atlantic City

By KEITH HENNEY

Associate Editor, Electronics

TECHNICAL opinion regarding the Radio Manufacturers Association trade show at Atlantic City in June was unanimous—there was little new to interest engineers. The ennui from which technical men suffered after a casual glance at the offerings was not lessened after a more complete examination of what existed within the cabinet. Whether the engineers will find something new under the radio sun this year will depend largely upon what the few manufacturers who did not display at the show have to present.

Perhaps these manufacturers already have something technically new to offer; perhaps they will develop something new. Certain it is that the many rumors which filled the Convention Hall are without much foundation. One rumor had it that at least one of the not-to-be-seen sets would be built around a pentode tube. General opinion, however, was that the year 1930 would not be marked by any radical technical change or advancement. Certainly nothing to compare to the introduction of a.c. tubes; the dynamic speaker; or the debatable advantage of the screen-grid tubes, may be expected this season.

General trends were toward use of pre-selection, especially in screen-grid sets; increasing application of the screen-grid tube, i.e., as radio and audio amplifier and as detector until it is leading the 227-type as a general-purpose tube. While the majority of manufacturers showed their preference of the triode as detector, eleven lines used the tetrode as the demodulator. In the audio system, push-pull 245's seem universal; the detector and this final stage are very frequently coupled by means of a resistance-coupled extra tube. Thus the modern set has decreased its audio gain b in spite of screen-grid radio-frequency amplif increased gain.

In the radio-frequency amplifier there is an of three stages, although some use four and so along with but two. A majority of receivers ha adjustment for varying antenna lengths; not m away with the signal and static collector entirely in spite of high-gain screen-grid tube amplifier minimize the cross-talk and local modulation p from which many sets of a year ago suffer, som of tuned circuit is interposed between antenna and the first r.f. stage; this shock absorber ma band-pass filter or a simple tuned circuit.

At least one manufacturer displayed a console in are built two receivers, one for the broadcast sp and one to cover the thousands of frequencies as "short waves." Several manufacturers separa radio frequency amplifier and detector from the power supply, and speaker apparatus. Con advance toward greater ease of tuning was appar

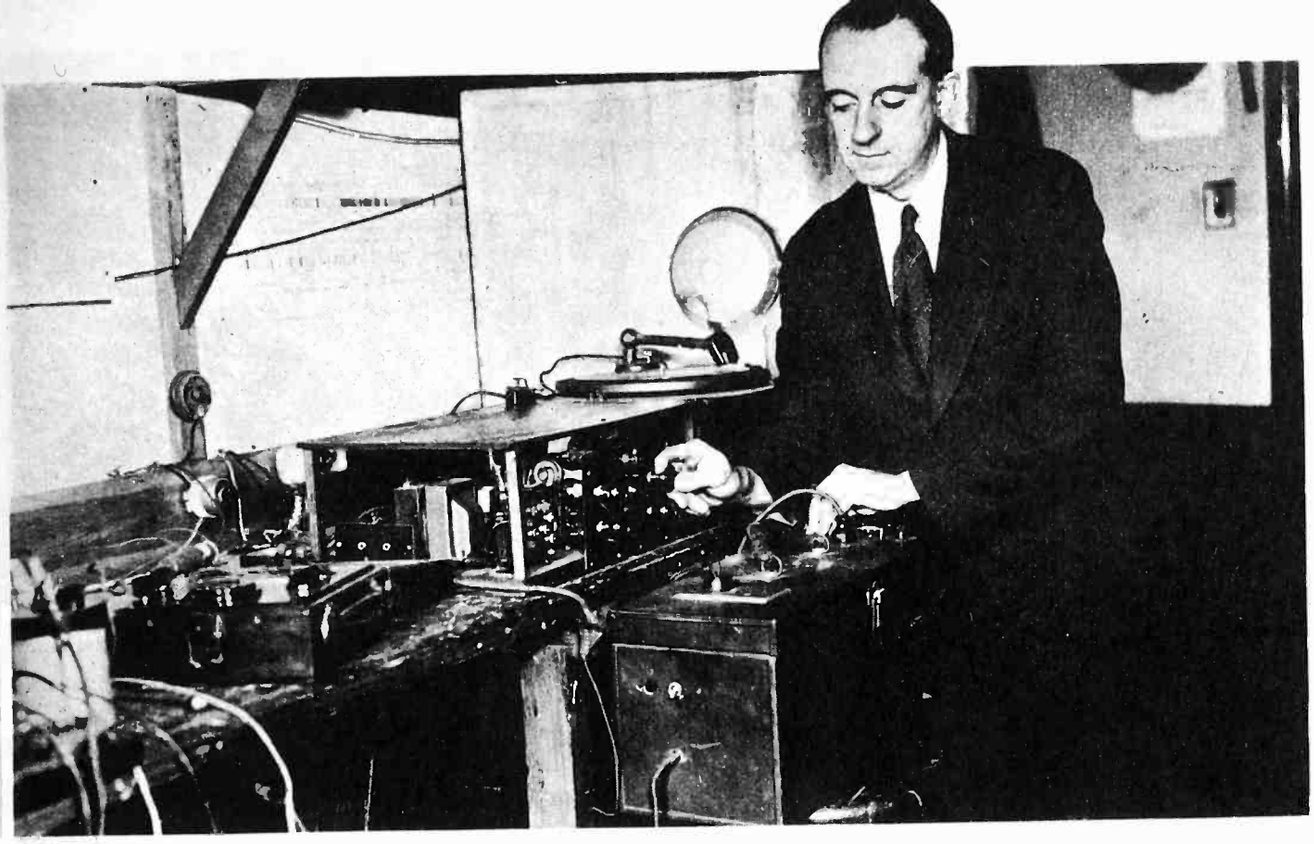
Hold a cup below the spigot and ice water gushed forth! A photo-cell novelty in the Arcturus booth

Public address systems

A notable increase was evident in the ber of people engaged in making an apparatus for public address install for theaters, as part of sound-picture p tion, and for centralized music (radio, graph, or with microphones), for apartment houses, etc. The public-a business, to use a general term for all systems involving appreciable power, to be in the same state as radio of years ago. Apparently the surface is be scratched, the average manufactur worrying about patents or lack of either stating "let them come after m "what patents are there which ar good?" or "well, I have patents, too."

These sound systems are, however, ferent proposition from a radio re They involve high voltages, costly equip and are not to be operated by enthu and well versed radio fans. They m engineered; not thrown together. A the installations shown at Atlantic Cit all the earmarks of engineering: tall of meters, dials, transformers, and Some of them were on demonstration although the general idea seemed to be to make so sound the listener could not judge the fidelity, the g opinion was that even the newest sound systems well engineered to produce good quality music, a stay put.

Little new in loud speakers appeared, whether i direction of increased frequency range, or greate ciency. Several manufacturers have speakers whic handle power of the order of 25-35 watts, obvious for home use. In fact with the new moving p speakers (*see June Electronics*) which will go 12,000 cycles and handle considerable power and increased volume level ranges now possible due t proved technique in processing the film and othe vance, it is probable that the near future will sound-pictures to the point—not yet reached—whe



Julius Aceves, consulting musician-engineer, demonstrating his system for correcting high- or low-note suppression occurring in loud speakers, radio receivers, or phonograph records, by proper compensation in the audio amplifier itself

uction is better than obtainable from a high-class

ne of the technical meetings in Atlantic City there ne indication that new speakers are in the experi- ta stage, but little of a quantitative nature could be rtined.

Tone control

h most evident popular technical "advance," and which prospective purchasers will hear much about, ne control. Most of the so-called controls merely se the high frequencies and thereby apparently ip the bass. Few of them are really controls in ey can accentuate the bass or treble as desired; e largely lossers for high frequencies already deci- by side-band cutting.

the meeting of the Radio Club of America, June 3, Aceves, a musician-engineer, New York City, strated the benefits of increasing both bass and requencies by means of amplifiers in which tilts en given to the two extremities of the frequency teristics. Deficiencies in phonograph records or peakers were overcome by means of these ampli- The fortunate fact about Mr. Aceves' work lay fac. that he is not only a good engineer but a ian as well. In the hands of the layman-musician ontrol devices are probably not advisable; but when ician equalizes the defects of one part of the sys- y giving a tilt to another and more flexible part, ffect has a good chance of being correct. The siasm of the audience who heard the demonstration rs well for its adoption by the industry.

New tubes

ttle was heard about new tubes, whether pentodes, y-cell tubes. A recommendation to the New Tube mittee of the R.M.A. was made that tube manu- rers spend time allotted to pentode research on five- element tubes to replace the present dry-cell power tubes which deliver too little power and to let well enough alone in the a.c. power tube field.

A new type of tube in which an electron stream is transformed into mechanical motion was demonstrated by Allen B. DuMont. Although little use has as yet been found for the tubes, it is probable that sceptics were as evident when DeForest announced his three element device.

The meetings of the I.R.E. were devoted to problems of production, design, measurement, and control.

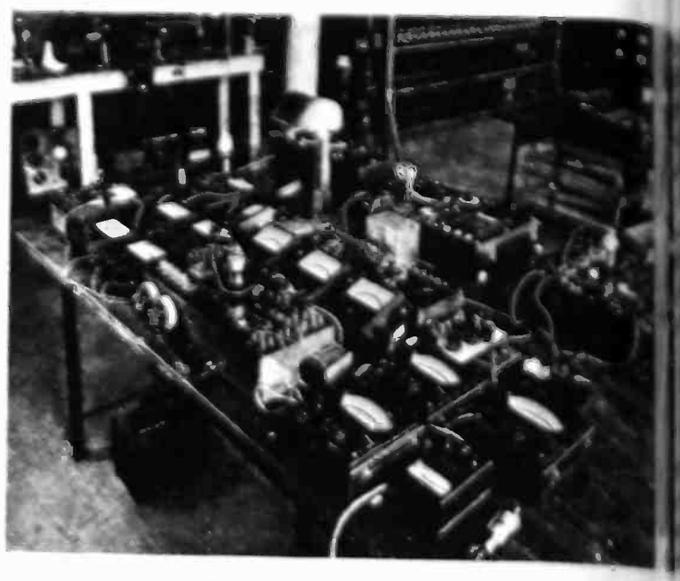
Allen B. DuMont, DeForest chief engineer, and his new tube with a rotatable grid which revolves under impact of the electron stream

A study of the

Chemical phenomena in coated filaments

By EDGAR R. WAGNER, Ph.D.

Chief Chemist, Duovac Radio Tube Corporation



Part of the equipment for static and dynamic tube measurements

IT IS quite generally conceded that the source of electrons from a coated filament is a layer of active metal, usually barium, strontium, or a mixture of these two. The location of this layer is, according to some, on the surface of the coating, and according to others, on the filament itself. Recent developments indicate the correctness of the latter view, but do not disprove the possibility of active material being present at the surface of the coating.

The origin of this metallic layer remains the source of much conjecture. Various theories have been advanced, such as reduction of barium oxide by the base metal of the filament, electrolysis, and positive ion bombardment.

This paper is an attempt to analyze the various processes that a filament is subjected to during the production of a tube.

It is a matter of experience in tube manufacture that some filaments show marked activity before ageing, while others show practically none at all if the filament has been oxidized prior to coating it. When the filament is made of nickel, silico nickel or titanium nickel, the tube is active before aging if the filament temperature has been properly controlled during the pumping. When nickel chromium alloys are used, little or no emission is available before activation on the aging rack.

The mixture of barium and strontium carbonates usually employed is merely baked on to a superficially oxidized filament when a nitrate binder is used. After passing through the drying furnaces, the coating still contains about 2 per cent of water, and the nitrate crystals cement the carbonate particles together, and to the roughened filament surface. After evacuating and aging, no nitrate is detectable in the coating, which is now composed largely of barium and strontium oxides, with small amounts of carbonates. Its adhesion to the filament is due to friction at the interface together with a certain rigidity of the mass as a whole that re from interlocking particles.

The same result is obtained when organic binders as nitrocellulose lacquers are used, although the co of coating and metal is not so good as when a w bound mixture is used.

Advantage of colloidal carbonate coating

In the writer's experience, colloidal carbonates ad most firmly to the filament, and particles of co dimensions give a more active coating than do the o nary fine precipitated carbonates now commerc available. The higher activity of the colloidal carbo coating is probably due to the fact that more parti are in contact with the filament per unit surface than is the case with ordinary carbonates, which very desirable feature from the viewpoint of all theo of coating activity. There is a limit, however, to den of coating, and this is reached when the particles an fine that they are so closely packed as to interfere v electron emission. This condition is rarely reache practice unless foreign salts such as sodium or po sium chloride, nitrate or carbonate are present. In case a semi-vitreous mass may result which permits passage of electrons only on an ionic carrier as in fused electrolyte, and at velocities of very few c meters per second.

If this condition is encountered—and a commer preparation has been available that contained a relati large amount of fusible salt—the emission of elec from the filament is limited by the number of i carriers that transport them through the sintered m The reason for this is the fact that the electrons betw filament and plate move with velocities that are th sands of times greater than the ionic velocities in coating. Usually, however, the amount of fusible is not so great that it interferes seriously with the path of the electrons.

Other coating materials are in use, such as alcoh suspensions of barium and strontium oxides, and g results are obtained by their use. The alcohol Ba $(OC_2H_5)_2$ and Sr $(OC_2H_5)_2$ which result from interaction of barium and strontium oxides on e alcohol, are readily converted back to the oxides by h Good adhesion to metal is obtained because of inevitable presence of aldehyde resin, which forms w alcohol is exposed to air in the presence of an alkali.

ief objection to such coating materials is the
y experienced in obtaining pure BaO and SrO,
ommercially or by preparing them, and to their
sceptibility to moisture. The oxides, as well as
nolates, are very readily converted to hydroxides
sture, and these hydroxides are notoriously
t to give up their water. A "gassy" tube results.
ich a coating is properly handled, good emission
ned, which, however, is no better than results
ually intelligent treatment of carbonate coatings.

cess of conversion of carbonates to oxide

the filament is lighted during evacuation of the
composition of the carbonates takes place with
ncy that depends upon the temperature, the pres-
gas in the bulb, and the rate at which the energy
y for the conversion of carbonate to oxide is
e to the coating.
e case of a 280 filament, the amount of coating
nverted, per filament, is approximately 10 milli-
s. Let us suppose, for convenience, that this
mg is composed entirely of barium carbonate, whose
ar weight is 197 and which, when formed from
oxide and carbon dioxide, liberates energy as
y the equation,

$$BaO + CO_2 = BaCO_3 + 63{,}400 \text{ calories}$$

nersely, when $BaCO_3$ is decomposed to BaO + CO_2 an equal amount of energy must be supplied. For
g of $BaCO_3$, about 33 calories are required, equiv-
138 watt-seconds. With a 10-watt filament
it is evident that sufficient thermal energy is
d to the coating in less than a minute,—even
much of the heat be lost by radiation, to bring
ecomposition.
ee is another factor, however, which is much more
rtant than the question of having a sufficient quan-
heat reach the $BaCO_3$ molecules to decompose
. That factor is dissociation pressure.

Dissociation pressure is a measure of the tendency of the carbonate to decompose at any given temperature, and is expressed in atmospheres. It is the pressure that exists when equilibrium is reached between the molecules of CO_2 that are leaving the carbonate, and, those that are recombining, as expressed by the relation.

$$BaCO_3 \rightleftharpoons BaO + CO_2$$

This pressure may be calculated with sufficient accuracy by the Nernst approximation formula:

$$\log Kp = \frac{Qp}{4.58T} + \Sigma n\ 1.75 \log T + \Sigma n\ C$$

where Qp = heat of formation at constant pressure = 63,440 calories
Σn = algebraic sum of reactants plus resultants
T = absolute temperature, °Kelvin
C = empirical constant. Value = 3.2 for CO_2

If the temperature of the filament is 1,000° C, or 1,273° K,

$$\log Kp = \frac{-63{,}440}{4.58 \times 1{,}273} + 1.75 \log 1{,}273 + 3.2 = -2.236$$

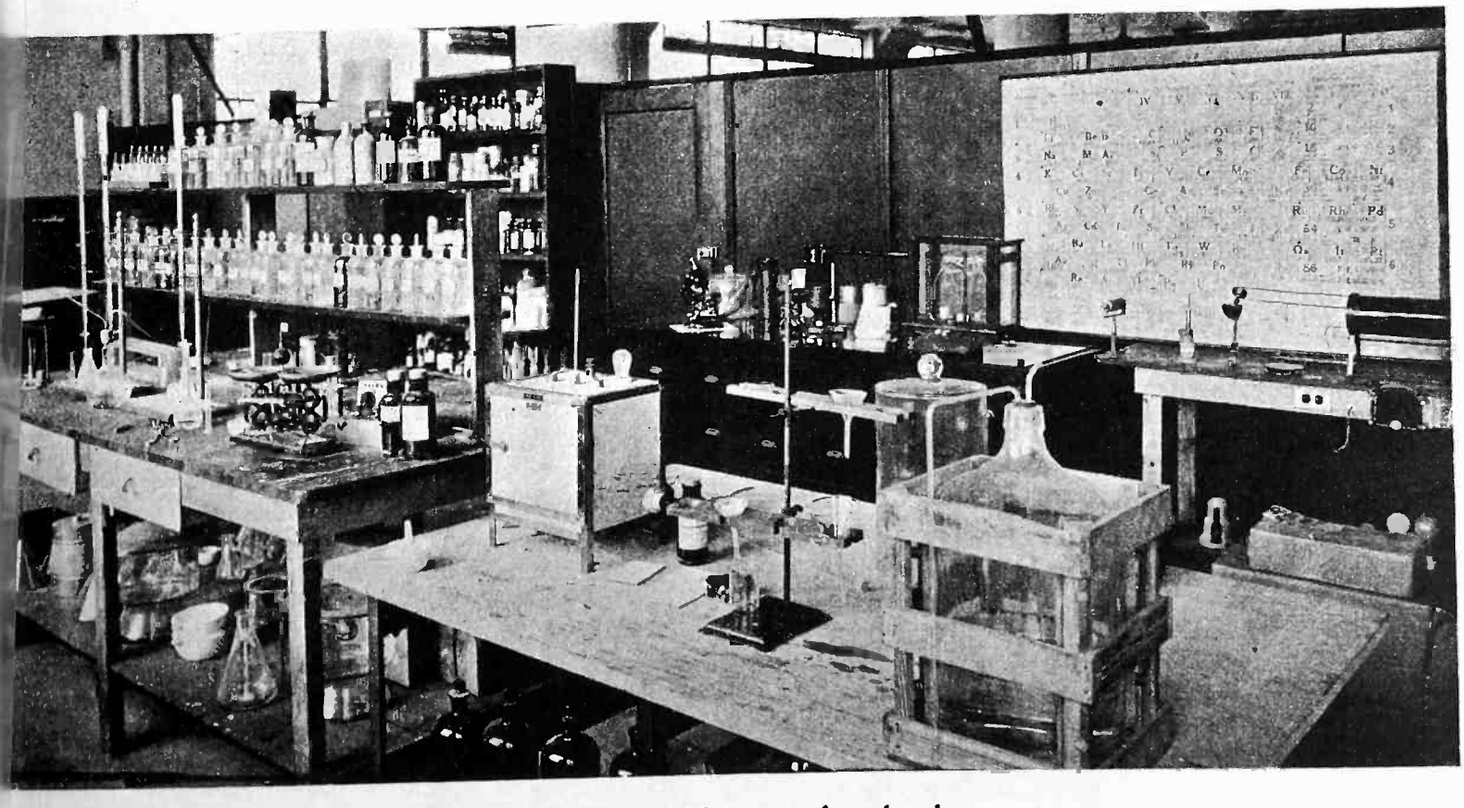
and $Kp = .01722$

at 900° C (1,173°K) $\log Kp = -3.240$ and $Kp = .00174$

Since equilibrium is determined by the pressure of CO_2 alone

$Kp = Pco_2$ and $Pco_2 = .01722$ atm. at 1,000° C
$= .00174$ atm. at 900° C

Ten milligrams of $BaCO_3$, when completely decomposed, will liberate slightly more than 1 cc. of CO_2, measured at 0° C. and 760 mm. Since the volume of the bulb is approximately 150 cc., and the gas fills the entire space, the resultant pressure is 0.0067 atmosphere. At operating temperatures, the pressure would be well over 0.01 atmosphere. This pressure is of the same order as the dissociation pressure when the filament is at 1,000° C., but is greater than the dissociation pressure at 900° C. In the latter case, incomplete conversion results unless the CO_2 is pumped out at least as fast as it is liberated, in order that the pressure of the gas in the bulb is kept below the dissociation pressure. At the higher temperature, slower pumping will not seriously hinder the conversion, since at 1,000° C., decomposition will be virtually complete if a fairly high vacuum has been established before the filament is lighted.



Corner of the chemical laboratory of a tube plant

It is evident from the foregoing discussion that complete conversion of $BaCO_3$ to BaO may be had in vacuo at temperatures that are very much lower than would be necessary at atmospheric pressure. It also follows that it is unnecessary to bring about the reduction of $BaCO_3$ to BaO by means of the addition of some carbonaceous substance, although such an agent would bring about conversion at a much lower temperature. Indeed, a readier conversion may be undesirable, since a rapid evolution of gas may blow the coating off the filament entirely.

When we have finished pumping the tube, the residual gas, after flashing the getter, is at a pressure of less than 0.05 micron.

If the filament is of nickel, considerable emission is present even though no plate or grid voltage was impressed during the pumping. If the filament is of nickel-chromium alloy, no appreciable emission is present before aging the tube.

Source of electron emission

Evidently, since oxidized nickel base filament is active and oxidized nickel-chromium base is inactive, the activity cannot be ascribed to barium or strontium oxides since they are present in both cases to equal extent. Furthermore, if BaO or SrO were the emitter, the emission would be proportional to the degree of conversion when measured under similar conditions. The following table shows that there is no such relationship since No. 6, with a high degree of conversion, has a lower emission than No. 2 with less conversion:

TABLE I—Type DX-280

	I_f	I_{p_1}	I_{p_2}	Wt. Coating	Vol. 0.022*N* *HCl* used	Vol. *HCl* per mg. of Coating
1.	2.10	30 ma	40 ma	11.9 mg	5.65 cc	0.458 cc
2.	2.10	110	110	10.6	4.35	0.410
3.	2.05	110	115	11.3	5.95	0.526
4.	2.05	100	110	12.1	6.85	0.566
5.	2.00	60	60	8.2	4.00	0.488
6.	2.20	30	30	11.1	6.10	0.549
7.	2.00	120	120	10.0	5.15	0.515
8.	2.10	120	120	11.1	6.25	0.558

Emission readings were taken with 80 volts Ep. The strength of the acid was sufficiently low to permit accurate determination of oxide content. The filament was removed from the tube, weighed, placed in distilled water, boiled, cooled, and titrated, using phenolphthalein as indicator. By adding the acid slowly and keeping the solution thoroughly agitated, a sharp end point was obtained and no carbonate was dissolved. The filament was again weighed with coating removed. We are thus obliged to look elsewhere for the source of the electronic activity.

It has been known for a long time that the metals of the alkali and alkaline earth groups are thermionically active and it is merely a question of whether or not the metal of the filament is able to displace metallic barium from BaO. Some idea of the probability of this conversion may be obtained by the use of the Nernst approximation formula, assuming nickel vapor to be the active agent, since an oxide layer lies between the coating and the metal itself. The heat of formation of BaO is 126,400 calories per gram molecule. The heat of formation of NiO is 57,900 calories per molecule.

$$\Delta H_{BaO} - \Delta H_{NiO} = 68,500$$

Substituting this value, and T = 1,273° K, the value

$$\log K_P = \frac{-68,500}{4.58 \times 1,273} + \Sigma n\ 1.75 \log T + \Sigma n\ C =$$

(1) and the ratio of $\frac{P_{Ba}}{P_{Ni}} = 5 \times 10^{-21}$

From the equation[1] $\log P = -52.23 \times \frac{A}{T} + B$, where A and B = 7.6 for nickel we may calculate the vapor pressure of nickel

(2) Log P_{Ni} = —4.91 mm. = .0008 mm. = 1.06 bars = 0.6×10^{-6} atm.

(3) From (1) and (2) $P_{Ba} = 5 \times 10^{-21} \times .6 \times 10^{-6}$ $= 3 \times 10^{-27}$ atm. $= .304 \times 10^{-30}$ bar

The equation[2] $m = 43.74 \times 10^{-4} \sqrt{\frac{M}{T}}\, p$ gives the mass of metal of atomic wt. "M" that exerts pressure "p" at temperature T. For barium, M = 137.37, T = 1,273° K, and "p" (3) is $.304 \times 10^{-30}$ bar.

$$M_{Ba} = 43.74 \times 10^{-4} \frac{137.37}{1,273} \times .304 \times 10^{-30}$$
$$= 4 \times 10^{-15} \text{ grams}$$

Since 137.37 grams of barium contain $6.06 \times$ atoms, 4×10^{-15} grams contain approximately $2 \times$ atoms. If each atom contributes an electron to emission current, then, since the charge on the el is 1.6×10^{-19} coulombs, the total quantity of elec available is 3.2×10^{-12} coulombs or 3.2 micro coulombs. This will not account for the observed i activity.

While these calculations are necessarily very r they furnish qualitative indications of what may be sidered the mechanism of the reaction.

Chromium, iron, titanium—among the metals us filament alloys, are chemically active enough to lib metallic Ba and Sr from their oxides, and yet a ni chromium-iron alloy, when coated in the same ma as nickel filament, is inactive. Evidently, the natu the metal of the filament is of minor importance as as activity of coating is concerned except where a face layer of oxide or adsorbed gas may interpose a resistance film between coating and filament. The i activity of coated platinum filament indicates the rectness of this view, since platinum is as inactive c ically as could be hoped for.

Bombardment as cause of activation

McNabb (*Jour. Opt. Soc. Amer. 19 pp. 33-41, 1929*) states that the underlying action of all met of activation is one of gaseous bombardment of coating. The result of this bombardment is supp to be the conversion of carbonate to oxide or to m

This would necessarily be a special case wherein metal of the filament did not react chemically with coating—as in the case of platinum filaments— where the coating had been incompletely converte oxide during evacuation of the tube. The conver of oxide to metal by bombardment—i.e., positive bombardment,—would require the kinetic energy of bombarding molecule to be of sufficient magnitud overcome the work done when barium and oxygen c bined to form BaO.

To calculate accurately the energy necessary to dec pose one molcule of BaO is very involved becaus lack of data on heat capacities of BaO at different t peratures. It may be calculated approximately from

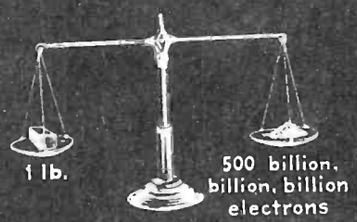
[*Continued on page 214*]

HE ELECTRON—its characteristics

FUNDAMENTAL is the electron that it is difficult to speak of its size, or weight, or shape. There n doubt that it has any such attributes; for very recent studies indicate that the electron may be nothing but a wave. The data below, however, may convey some idea of the characteristics of this basic "building unit."

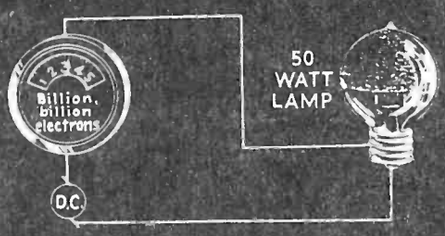
MASS — — — — — — 9×10^{-28} grams = 3.2 hundredth billionth billionth billionth ounce

ectron probably has no mass; but it though it had. It would take 500 billion billion electrons to weigh ound The hydrogen atom is the te of all atoms; it has about 1,800 the mass of the electron.

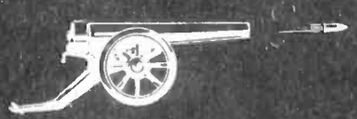


ELECTRIC CHARGE — — 4.774×10^{-10} electrostatic units = 1.59×10^{-19} coulomb

lectric current is nothing but a ia of electrons each carrying a unit or quantity of electricity. Thus int up a 50-watt bulb requires the e of 3 billion billion electrons per d. If a mechanical counter can these at the rate of one million per ol it would require 118,000 years to ete the task.



SPEED — — — — — — — — — — — — — — — from 300 to 125,000 miles per second



SHELL
2,800 feet per second

MOTORCYCLE
132 feet per second

AIRPLANE
300 feet per second

ELECTRONS IN VACUUM TUBE
1,000 miles per second

electron is not static; it is a dynamic, ing primordial unit. In the hydrotom the electron travels about 1,300 per second, and makes about 6,580 bn complete circuits a second. In complex atoms it may go as fast as 00 miles a second, approaching the of light.

SIZE — — — — — — — — — — — — — — — — — about 1/13 trillionth inch

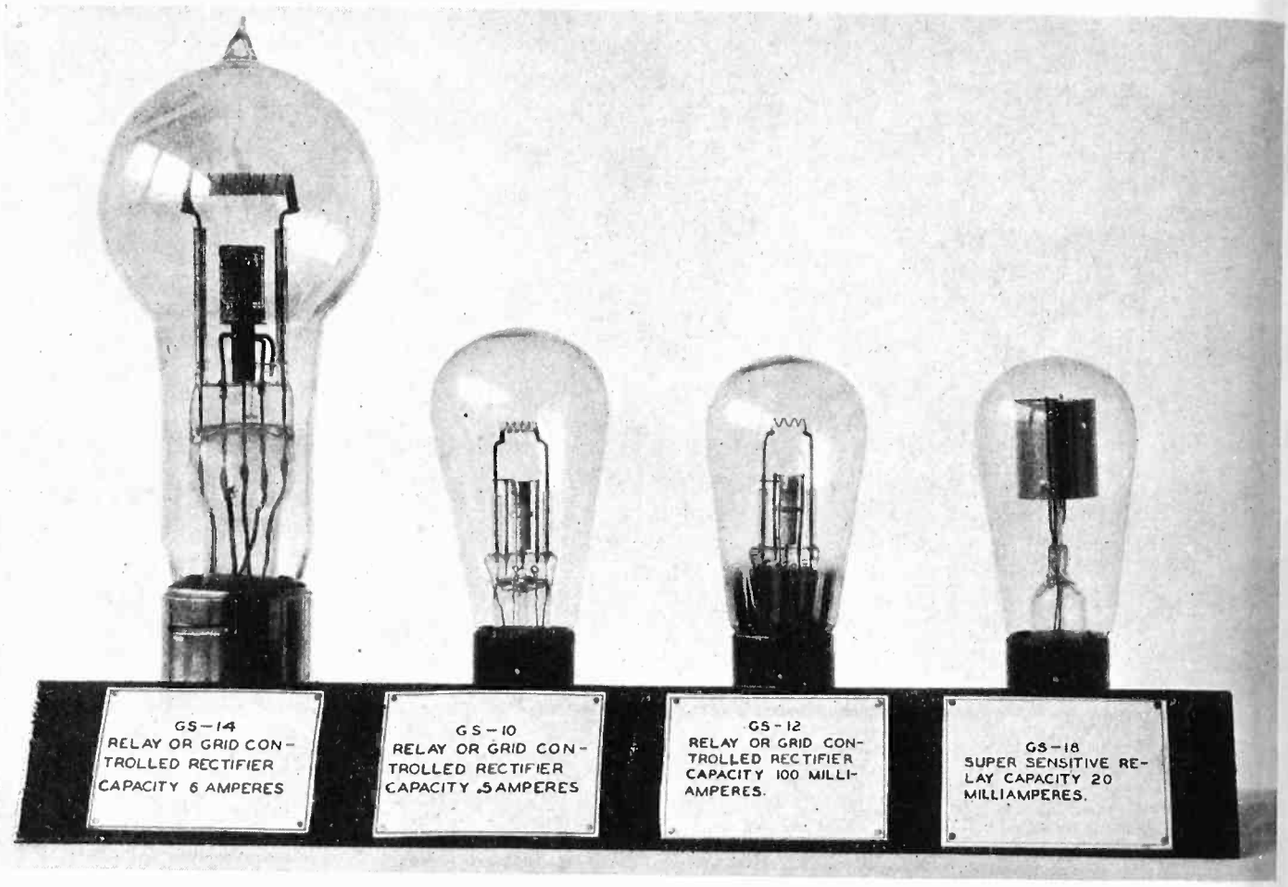
ELECTRON MARBLE THE EARTH

$\frac{1}{10,000,000,000,000}$ inch

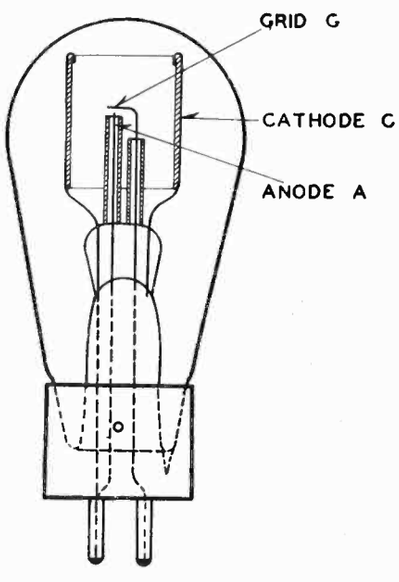
$\frac{1}{2}$ inch

electron is so small that if a marble e to be half way between the electron the earth in size, the earth would e be enlarged about 6,000 times.

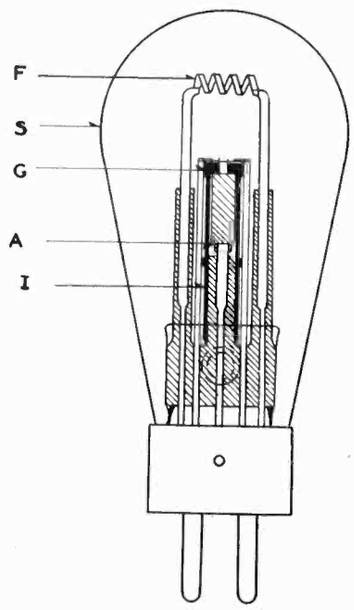
Vacuum Tube Relays of the Grid Glow Type



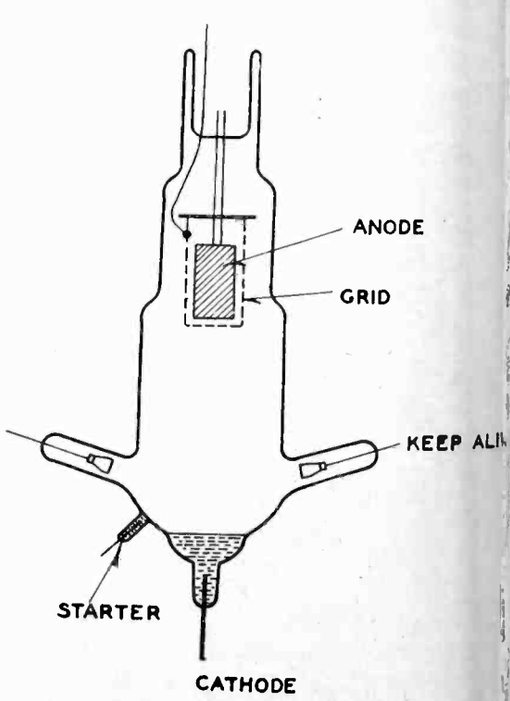
TUBES of the glow or arc discharge type operate as soon as the grid voltage is of the correct value; then the grid loses control. These tubes are gas tubes, using either an inert gas or mercury vapor. They act as relays controlling considerable power by means of a small grid power expenditure. The tubes above are rectifiers and relays.



Construction of a cold-cathode grid glow tube for low power control circuits.



A hot-cathode grid glow tube capable of handling considerable power.



A mercury cathode supplies peaks of current too great for an oxide filament to handle.

id-controlled

w and arc

charge tubes

D. KNOWLES

P. SASHOFF*

TH perhaps three exceptions, generators, motors and transformers, relays are the most important instruments with which the electrical e has to work.

r accepts the definition that a relay is a device by which a relatively small amount of energy may to control large quantities of power, then we list of such devices to be long and varied.

hoto-electric tube is a light operated relay. ay visible light falling upon the cathode of a photo tube increases the current carrying ca- normously. Its usefulness when used alone is by its small current carrying capacity.

um tubes, such as used in radio, are relays in all changes in grid potential produce considerable in plate current. Tubes in which glow and dis- are controlled by means of grids are relays of ng importance. At a critical value of grid input, suddenly operates and beyond that there is gen- o proportionality between input and output.

relays contain no moving mechanical parts, are y silent in operation and can be made extremely e. They can be made to control almost any of power and in many instances do it better than echanical competitors.

Conduction of electricity through gases

age of current through glows and arcs do not of a flow of electrons alone. The current is car- intly by electrons moving toward the anode and e ions toward the cathode. Their relative dis- ons vary continuously over the length of the dis- , electrons being most abundant at the anode, e ions at the cathode and at some intermediate they are present in approximately equal numbers. vacuum tube where all the carriers of electricity ectrons, a negatively charged grid will receive no

earch engineers, Westinghouse Electric and Manufacturing ny.

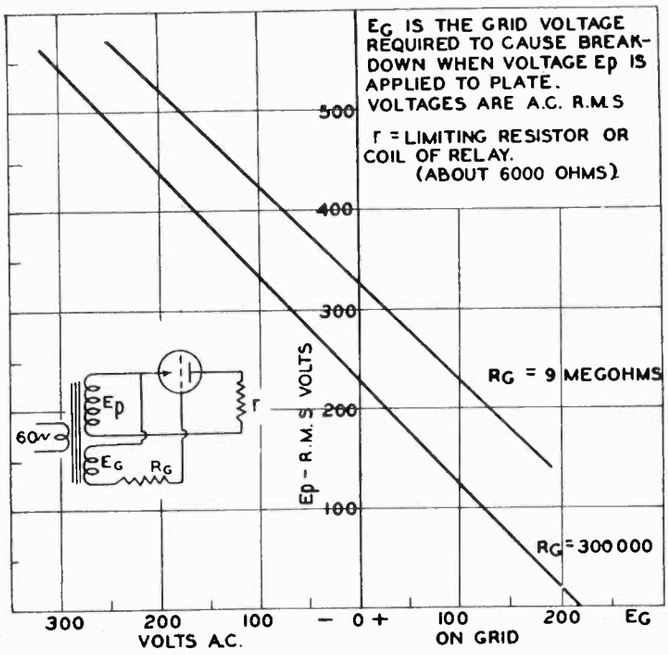


Fig. 1—Grid glow tube relay GS-18, grid voltage-plate current curve

current because all the carriers being negative also are repelled by it.

In a glow discharge or an arc, however, a grid will always receive a current except at one critical value of potential. This potential is one which causes electrons and positive ions to arrive at the grid at equal rates.

If the grid is made more negative than this, some of the electrons are repelled and more positive ions attracted, resulting in an excess of ions adjacent to the grid. If the grid is made positive, positive ions are repelled and electrons attracted, resulting in an excess of electrons near the grid.

It is characteristic of these devices that a discharge can be prevented but not stopped. On a.c. or a pulsating d.c. potential the discharge, of course, goes out on each zero point of the wave and the grid can be used to either prevent or allow the discharge to start on the next cycle. On d.c. they possess a lock-in characteristic which is sometimes desirable and sometimes undesirable; i.e., they may be held in the open circuit condition indefinitely by the proper grid bias until a voltage surge or some other disturbance momentarily changes the grid voltage and causes current to pass. Once started, the discharge cannot be stopped except by interrupting the anode potential.

Grid glow tubes

Fig. 1 shows two curves giving the effect of resistance in the grid circuit. A resistor of about 1 megohm or more is used in the grid circuit to prevent the grid receiving too much current.

When the grid bias is positive, the voltage between grid and cathode is the sum of the two voltages Ep and Eg. At a critical value of this sum (230 volts for Rg =300,000) a discharge starts between grid and cathode. For most values of Ep, the discharge transfers at once to the anode and operation is complete. The fundamental condition for operation is that the grid to cathode voltage be 230 volts or more and at the same instant enough voltage exist between grid and anode to transfer the discharge.

Any source of variable voltage applied to the grid will start the discharge when it exceeds a critical positive value, or if reversed in polarity and Ep increased accordingly, a similar increase will stop the discharge. For example, if

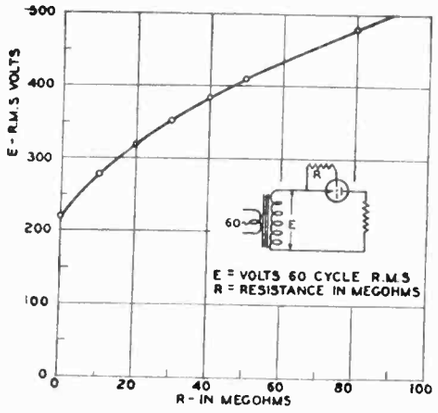


Fig. 2—Breakdown voltage-grid resistance curves, GS-18

Ep is kept constant at 200 volts, no current will pass for values of Eg less than 25 volts positive with respect to the anode or, of course, for any negative value of Eg. If the positive grid voltage equals or exceeds 25 volts, however, current flows at once in the cathode circuit.

In Fig. 2, the starting voltage is plotted as a function of the resistance connecting the grid to the anode. It is seen that the resistances are of the order of several megohms so that photo-electric tubes, flames, water, surface leakage over insulators and many such materials or conditions furnish the necessary conductivity to operate the tube as a relay. Small capacities may be made to control the starting in exactly the same way. This has been taken advantage of in the design of a demonstration set in which the capacity of one's hand when brought near a sign in a store window will cause the tube to operate and set in motion any apparatus which the store may care to feature.

Phase control

Continuous variation of output current as a function of input is sometimes desired in preference to the "trigger" action which has been discussed. This may be accomplished by shifting the phase of the grid voltage relative to the anode-cathode voltage, thus controlling the point on the cycle at which discharge starts. Once started, the discharge lasts for approximately the balance of the half cycle and then goes out. If breakdown occurs near the end of each half cycle the average current is small, etc. The output may be thus controlled continuously from essentially zero to a maximum value.

The necessary phase shift is usually accomplished by one of the following well known methods: 1. Variable resistor in series with a condenser. 2. Variable condenser in series with a resistor. 3. In some cases combination of inductance, resistance and capacity. Phase control by means of a photo tube in series with a fixed condenser is conveniently arranged and in many cases is more satisfactory than "trigger" control.

Figure 3 shows the circuit for such control in which increasing illumination on the symmetrical photo cell causes a continuous increase in the current output. The operation is simple. When the photo tube is dark, it has zero conductivity and *C* receives no charge. As the conductivity of the photo tube is increased by incident light, the condenser finally acquires enough charge to start the grid glow tube near the end of the cycle.

Hot cathode grid glow tubes

The extreme sensitivity, speed and accuracy of the cold cathode grid glow tube assured its immediate success.

The hot cathode grid glow tube was developed to meet the demand for a device combining the features of the cold cathode grid glow tube-mechanical relay combination, but eliminating the disadvantages imposed by mechanical relay. It, thus, answered the need for a "contactless relay" of large current carrying capacity. It can be operated directly on commercial line voltages whenever desirable. The power grid glow tube is inherently a grid controlled rectifier. As such it has numerous applications in circuits where it is desirable to control the effective power output.

When the filament of a 0.5 ampere power grid glow tube (known as GS-10) is heated to a given temperature the filament emits electrons. As these electrons have sufficient velocity, they, in colliding with the molecules of the gas, ionize the latter and will produce new electrons and positive ions. The positive ions so produced neutralize the space charge in the tube decreasing the voltage drop. The drop in the oxide filament power grid glow tube at rated filament temperature is about 15 volts for mercury vapor and approximately 30 volts for neon gas.

Characteristics of power grid glow tube

Figure 4 shows the fundamental curves of the power grid glow tube. A direct current voltage is applied between the anode and the cathode and the potential of the grid is obtained from the variable point on a 3 megohm resistance potentiometer. The various curves

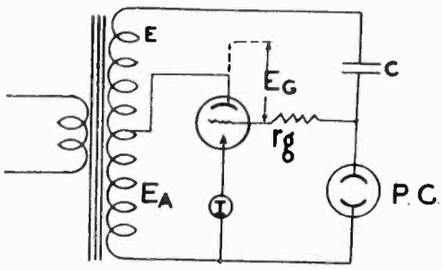


Fig. 3—Type circuit

which coincide for the higher voltage, correspond to different values of grid leak resistances. The potentiometer method of grid control has been found satisfactory in many applications where it has been desirable to select only a given portion of a pulsating signal.

If the direct current voltage on the anode is regulated by alternating current voltage while a direct current is supplied to the grid, the curves on Fig. 5 are obtained. Each of these curves corresponds to a different value of capacity shunted between the grid and the cathode thereby changing the phase angle between the cathode and anode-grid voltages and changing the magnitude for which breakdown will occur. The other circuit conditions constitute very convenient

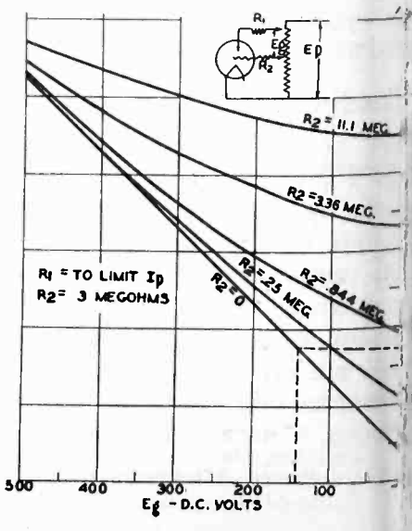
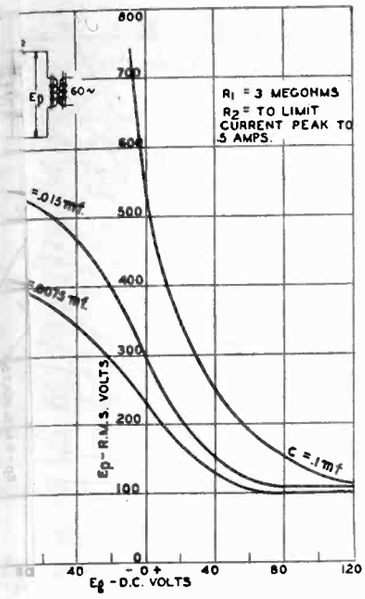


Fig. 4—Potentiometer control, power grid glow tube, GS-10



5—Grid bias-A.C. plate
ge characteristic, GS-10

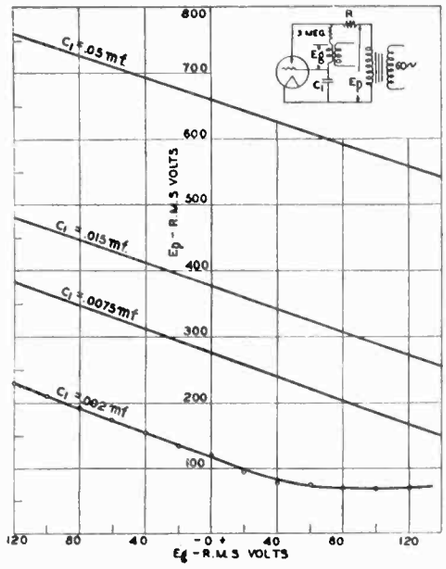


Fig. 6—A.C. grid bias-A.C. plate voltage characteristic, GS-10

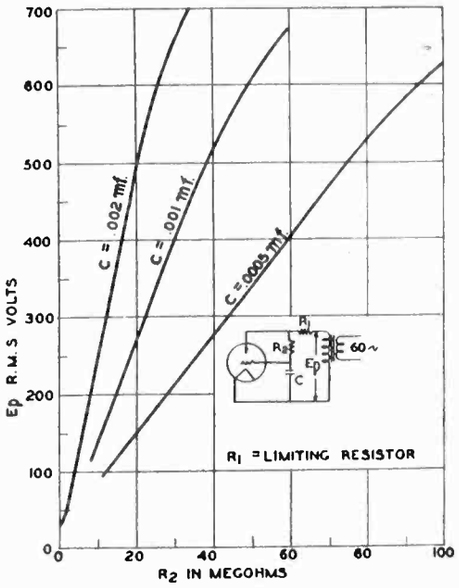


Fig. 7—Resistance control characteristic, GS-10

phase-shifting by means of which the power f the tube can be controlled as has been mentefore.

urves on Fig. 6 are obtained by substituting for ct current bias alternating current voltage obom the secondary of a transformer the primary is supplied from the same source supplying the thode potential. The curves on this figure are phase difference between anode-cathode and id voltage. This circuit or modification of it used to perform all sorts of operations at the f appearance of a predetermined value of grid botential. A typical example is the starting of a ray oscillograph within a fraction of a microafter a lightning disturbance on a transmission different set of curves is obtained by making self biasing through a resistor. The curves for dition are shown on Fig. 7.

Gas filled versus mercury vapor tubes

the temperature has a negligible effect on the eristics of the tube when filled with neon, it afry markedly the breakdown potential of tubes ith mercury vapor. This fact suggests a new ion for the mercury vapor tube: i. e., temperature The advantages and limitations of the two types summarized as follows:

illed Tubes:
antages:
Unaffected by operating temperature
Ready for operation as soon as the filament is hot.
itations:
An arc drop of thirty volts
Moderate flashback voltage.
ry Vapor Tubes:
antages:
Low arc drop (fifteen volts)
High flashback voltage.
itations:
Greatly affected by temperature
Long time required for the tube to reach equilibrium condition.

power dissipated in a power grid glow tube deboth on the amount of current carried by it and ergy supplied to its filament. In general, these un at a fairly high temperature, so that precautions be taken to prevent rapid chilling such as would sed by touching them with cool metal objects or sprinkling with cold liquid. Free circulation of air is desirable at all times.

There are many applications where it is desirable to use a tube capable of withstanding severe overloads of short duration. An oxide cathode tube cannot carry a load beyond the capacity of its filament. To fill such an application, then, such a tube will require a very large filament which must be maintained at operating temperature at all times.

A tube known as the mercury pool cathode power grid glow has been developed to meet the requirement of large instantaneous current demand and still have a very low cost of operation. The cathode now has been replaced by a pool of mercury such as used in mercury arc restifiers.

The operation of the tube, follows that of the one with oxide cathode. The primary electrons in this case are obtained by maintaining an arc between the keep-alive electrode and the mercury pool. When an arc strikes between anode and cathode, a spot is formed on the surface of the mercury pool which serves the same purpose as the filament of the oxide cathode power grid glow tube; i.e., as a source of electrons necessary to maintain the discharge. This spot, known as "cathode spot" unlike the oxide filament, has an unlimited electron emitting capacity and can, therefore, handle the severest of overloads. The formation of the "cathode spot" is accomplished by a drop of potential at the cathode. The voltage drop in this case, however, is small, so that the total drop in the tube is between nine and eleven volts. The breakdown point of this tube is affected by the mercury vapor pressure which depends on the intervals between operations.

In this paper we have endeavored, by means of representative characteristics, to point out the usefulness of grid controlled glow and arc discharge tubes in general. It is recognized, of course, that such a treatment cannot possibly be a complete guide to the successful use of these devices. This is especially true when it is considered that the actual overall operation characteristic is as much a function of circuit constants as of tube design. We express our thanks to Dr. Dayton Ulrey of the Research Laboratory, for helpful criticism.

(1) Photocells and Their Applications. Dr. V. K. Zworykin and Dr. E. D. Wilson (John Wiley & Sons Co.).
(2) *G. E. Review*, 26, 731, 1923.
(3) *Electric Journal*, February, 1930, p. 116.

Directional characteristics of loudspeakers for theaters

By LOUIS MALTER

Research Engineer, RCA-Photophone, Inc.

A CURVE showing the intensity of sound radiation from a loudspeaker in any direction relative to the intensity along the normal to the speaker mouth and at the same distance from the speaker mouth is defined as the directional characteristic of the loudspeaker at the frequency used in making the determination.

The influence of the directional characteristics of a loudspeaker upon the quality of reproduction of speech and music whether in the home or in the theater is a factor whose importance does not seem to have been generally appreciated and which has consequently been largely neglected by previous writers on the loudspeaker art.

In attempting to arrive at an absolute determination of the performance of a loudspeaker or in making a relative comparison between two or more loudspeakers it is common to limit oneself to a study of the frequency response characteristic taken along the speaker axis under free space conditions. The criterion set up for good fidelity is that the characteristic obtained in this manner be flat. It is apparent that this assures satisfactory reproduction along the normal to the speaker mouth only. To insure satisfactory response in all directions it is necessary that the frequency response characteristic everywhere in space be flat. In order to attain this ideal state, the loudspeaker must have the same directional characteristics at all frequencies.

A consideration of efficiency and the effects of reverberation leads to the conclusion that the directional characteristics, in addition to having the same shape at all frequencies, must be of such a form as to yield a uniform incident sound distribution over the entire audience and zero sound elsewhere. By so doing, two results are accomplished: the localization of the sound where it is desired, and a decrease in the reverberation effects due to the fact that the sound is initially incident upon the highly absorbing audience. The reverberation time, in this case, which is in general different, and in this c smaller than the usual reverberation time defined terms of a uniform initial sound distribution, may defined as the *effective reverberation time.*

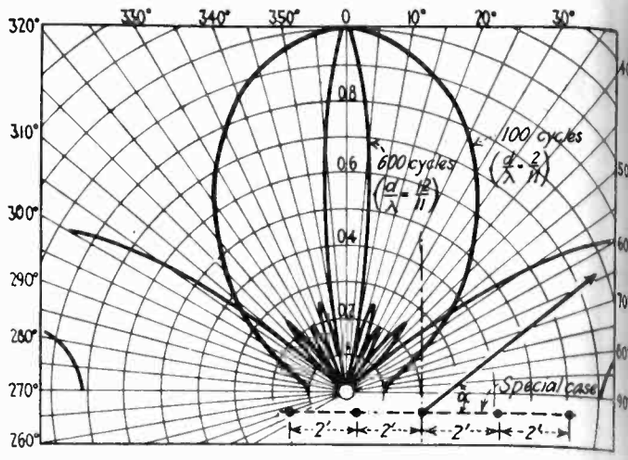


Fig. 1—Theoretical directional characteristics of 5 point sources on line

Theoretical directional characteristics

Before examining the directional characteristics various experimental and commercial types of sou sources it will be of interest to study the theoreti characteristics of a number of particular types of sourc

The directional characteristics are determined at distance sufficiently great from the source so that li joining a point at this great distance with all points the source may be considered as parallel.

The theoretical directional characteristics are co puted relative to the intensity at a distant point if radiation from all the points of the source arrived the distant point in phase. (Such a point does n necessarily exist.) $R\,\alpha$ is used to represent this relat intensity.

Point Source

A point source radiates uniformly in all directions. Th fore in this case:

$$R\,\alpha = 1$$

Combination of Point Sources

Linearly arranged, all in phase. (See Figure 1.) In this case:

$$R\,\alpha = \frac{\sin\left(\frac{n\pi d}{\lambda}\right)\sin\alpha}{n\sin\left(\frac{\pi d}{\lambda}\right)\sin\alpha}$$

where: α = angle between direction in which relative inten is being determined and the normal to the line of sources,

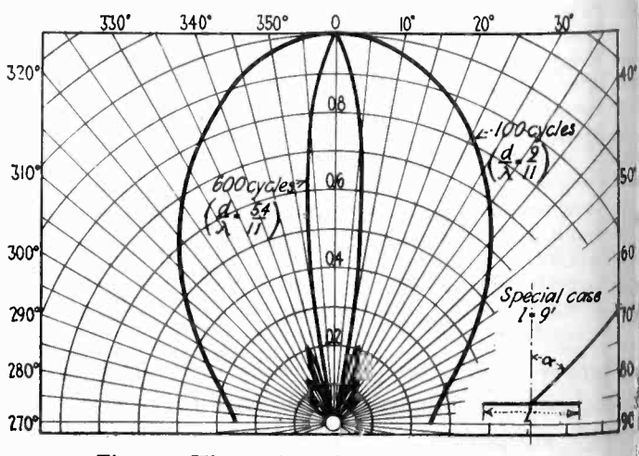


Fig. 2—Theoretical directional characteristics of line source

umber of point sources,
avelength of emitted ra-
ation.
haracteristic has the form
antly recurring maxima of
unity between which lie
2) smaller or secondary

directional characteristics
se in which $n = 5$ are
n Figure 1, for values of
and $\frac{12}{11}$ corresponding to
es of 100 and 600 cycles
urce wherein $d = 2$ feet.
he theoretical results
ressible in terms of $\frac{d}{\lambda}$
orresponding function.
ows that a change in
ry will not result in a
characteristic as "d"
ed by the right amount.
omputation for cases
ch the phase of the
not all the same but
a progressive phase
sts between successive
urces, shows that by
f the introduction of
per phase shift the
maximum of radia-
be made to take on
ection and not neces-
at perpendicular to the line of sources.

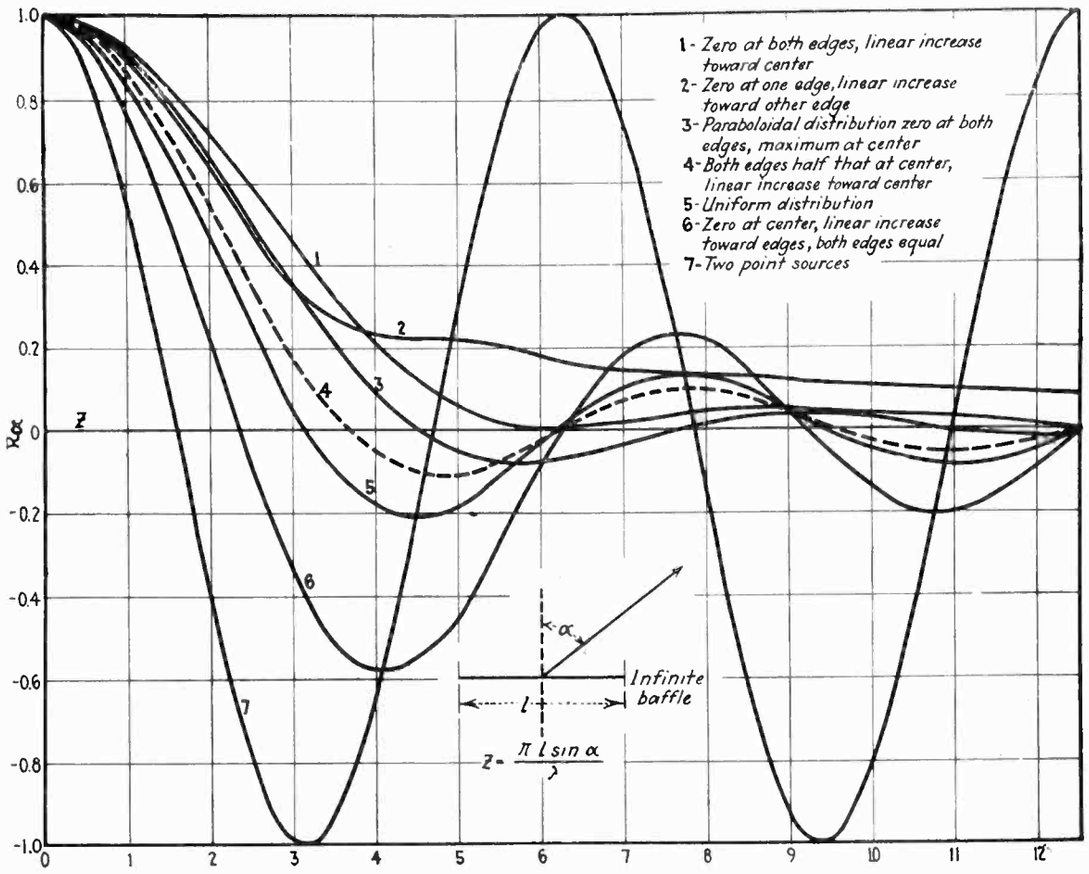


Fig. 3—Directional distribution characteristics of sources with various intensity distributions along source

The characteristics of a uniformly radiating line
f length equal to the linear array of point sources
so determined. The characteristics for $\frac{d}{\lambda} = \frac{9}{11}$
$\frac{54}{11}$ where d = length of line) are shown on Fig. 2.

this case, the secondary maxima do not rise to large
ess gain as is the case with the array of point sources.

Line source, non uniform intensity all points in phase

mber of line sources of non-uniform intensity
plotted on Fig. 3. It is seen that if the intensity
is toward the edges, the characteristic is broader
r the uniform source, whereas the converse is
the intensity rises toward the edges. This is
ight be expected since a decrease of intensity towards the edges is equivalent to decreasing the length of the source and a rising intensity towards the edges means that the case of a two-point source is being approached, which source has a sharper characteristic than the corresponding uniform source.

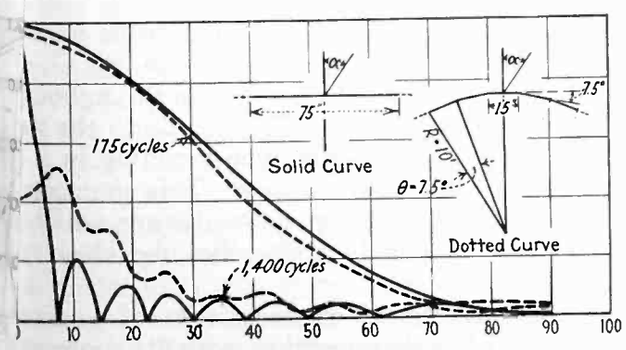


Fig. 4—Directional characteristics of combination of line sources

Circular arc, uniform intensity and phase

The result in this case comes out in the form of an infinite series of Bessel's functions of ascending order. Due to its slow convergence, this result leads to laborious computation and consequently an approximate solution was obtained by determining the characteristic for a source composed of a number of equal line radiators which are the chords of a circular arc.

The result obtained is: $R_\alpha = \frac{1}{2m+1}$

$$\left| \left[\sum_{p=-m}^{p=+m} \cos \left[\frac{2\pi R}{\lambda} \cos (\alpha + p\theta) \right] \frac{\sin \left[\frac{\pi d}{\lambda} \sin (\alpha + p\theta) \right]}{\frac{\pi d}{\lambda} \sin (\alpha + p\theta)} \right] + i \sum_{p=-m}^{p=+m} \sin \left[\frac{2\pi R}{\lambda} \cos (\alpha + p\theta) \right] \frac{\sin \left[\frac{\pi d}{\lambda} \sin (\alpha + p\theta) \right]}{\frac{\pi d}{\lambda} \sin (\alpha + p\theta)} \right|$$

R is the radius of the circle of which the lines are chords
$n = 2m + 1$ = number of chords (assumed odd)
θ = angle subtended by one chord at center of circle.
d = length of each chord.
R_α has been computed for a special case wherein: $R = 10$ feet; $d = 2$ feet; $\theta = 7.5$ degrees at frequencies of 175 and 1,400 cycles.

The results are plotted on Fig. 4. For purposes of comparison there have been plotted on the same sheet the characteristics which would be obtained if the chords were arranged so as to form a straight line.

These curves show that at low frequencies the charac-

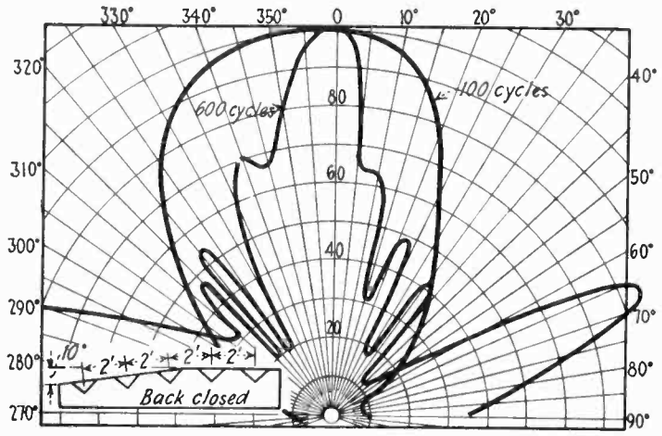


Fig. 6—Directional characteristics of 5-cone combination

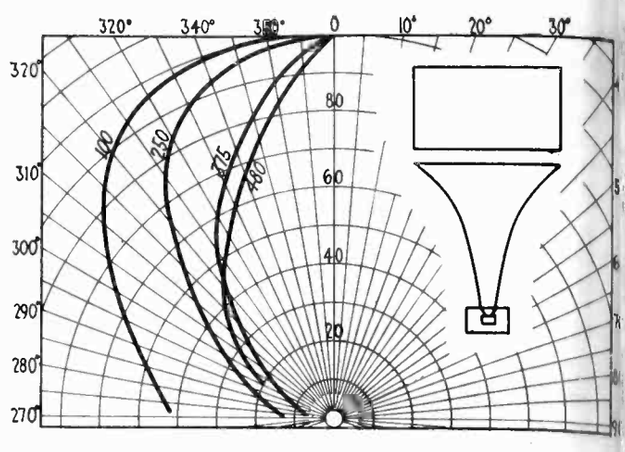


Fig. 7—Directional characteristics of directional baffle loudspeaker along long axis of mouth

teristics are substantially the same. At higher frequencies, however, the characteristic of the circular arrangement of lines is broader and flatter than that of the corresponding line source, in fact it shows a tendency to radiate uniformly throughout the angle defined by the centers of the two extreme line sources.

From a study of the above directional characteristics it is immediately evident that no sound source of reasonable dimensions could yield such a characteristic. The next best thing to aim at is a source which radiates uniformly in all directions. The added reverberation effects due to this type of distribution are not necessarily deleterious in a small room. They may help to compensate the general low reverberation time of broadcast studios.

In theater reproduction where reverberation effects must be cut down to a minimum, a sharply defined characteristic is desired. The characteristics obtained show that the circular arc source approaches the ideal most closely in this respect and should be the type approximated in practice.

Experimental directional characteristics

The directional characteristics of a single 12-in. cone set in an infinite baffle were obtained by mounting the cone in a closed box and setting the box in the ground with the cone pointing upward so that the top of the box and the face of the cone were flush with the surface of the ground. The results obtained are plotted on Fig. 5.

Below about 700 cycles the cone behaves like a point source radiating uniformly in all directions. Above this frequency the characteristic becomes sharper and sharper until a frequency of about 2,000 cycles is reached, above which frequency the beam remains fairly uniform.

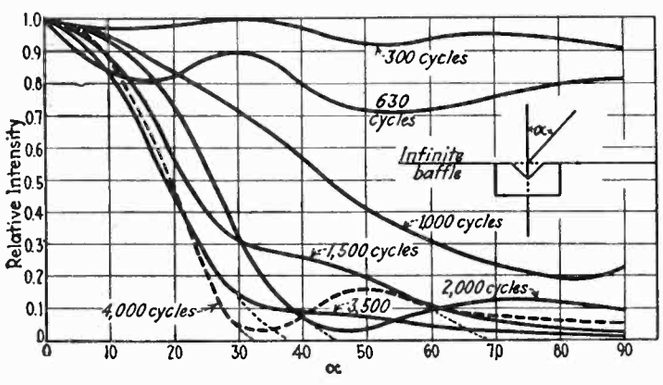


Fig. 5—Directional characteristics of 12-inch cone

Due to its availability a slightly dissymmetrical so was employed. (See Fig. 6 for sketch.) This sl dissymmetry does not, however, affect the conclus drawn.

Five 12-in. cones were mounted in a box with centers 2 ft. apart. The back of the box was close order to eliminate interference due to radiation f the rear.

The characteristics in the line of cones at freque of 100 and 600 cycles are shown in Fig. 6. T curves may be compared with those of Fig. 1, w show the theoretical characteristics of the analo points source combination. At higher frequencies w the cone themselves are directional, the agreement longer exists.

This would not be a good arrangement for the use due to the large secondary maxima present. theater these maxima would be directed away from audience and if reflection occurred, they would inter with the direct radiation, resulting in lowered un standability of speech.

Making the spacing between the cones uneven not eliminate bad secondary maxima. However, pla the cones in contact results in a greatly improved c acteristic due to the fact that a line source is appr mated.

Characteristics of directional baffle loudspeak

Directional characteristics of a large number of mercial and experimental sound sources have obtained. These showed varying degrees of sati tion.

The characteristics of a directional baffle loudsp along long axis of mouth are shown in Fig. 7. characteristics are remarkably uniform throughout a siderable frequency range. This is due to the mo flare of the baffle in this direction resulting in a co wave front at the mouth opening. This characteris similar to that radiated from a circular arc, which a seen above, most closely approaches the ideal for ater use.

The good directional characteristics of a direc baffle type loudspeaker together with its more un frequency response, account for the naturalness of r duction of speech and music obtained in theaters this type of speaker.

atent cases in the courts*

By JUDGE JOHN W. VAN ALLEN

General Counsel, Radio Manufacturers Association

ONG the outstanding questions in the Courts re-ently presented for decision are:

In the case of *United States of America vs. Corporation of America,* questions of the Federal rust Laws are involved and if the decision is s the Radio Corporation of America, the Court ecree a re-distribution of all patents to the owners ncellation of the cross-licensing arrangements be- the General Electric Company, Westinghouse & Manufacturing Company, American Tele- and Telegraph Company and others, and as eal thereto, there may result a denial by the r| Radio Commission of certain wave lengths to ompanies or affiliated companies under the pro- of Sec. 13 of the Federal Radio Act by reason of ecision.

nuch as the Radio Corporation of America has dlicenses to thirty-four companies to make radio vig sets and fourteen companies to make radio s, t may be presumed that existing radio receiving ructures embody more or less all or some features 4,000 odd patents owned by the companies in- in the suit which licensees constitute a large ry of the present radio-set manufacturers of the te States.

validity of these patents is not involved in this

ubtless few if any of these licenses extend for the le of the patent and doubtless some of the licenses son expire as well as some of the patents.

to those licensees whose licenses are about to and as to those patents which have not expired, acturers must either:

Find a construction for their products which will ringe the patents; or

Contest the patents; or

Negotiate a license thereunder.

ether the Government is successful or unsuccessful suit, these manufacturers would still be dealing e same corporations with which they have dealt in st with reference to the 4,000 odd patents involved e difference would lie in whether they deal with separately or through the medium of one company present.

ether these separate companies would be disposed nt to the industry licenses to use their patents to xtent that the Radio Corporation of America has d out the policy of licensing the industry, or retain ll use thereof to themselves, as they would have nt to do by virtue of ownership of the patents existing patent laws, would have to be determined. ere is no law now existing making the granting of es under patents obligatory upon the patent holder ch holder has the exclusive right under present laws e owner of the patent to manufacture and sell the uments of the invention covered by the patent.

us, if the Government is successful, would the number of concerns with whom a manufacturer must negotiate be multiplied if he wishes to escape patent troubles as to the particular patents involved or if the Government is unsuccessful, remain the same. On the other hand, should the Court confirm the legality of the pooling and cross-licensing arrangements, a large proportion of radio patents would be held by a single company as at present.

Lowell and Dunmore Cases

In the suit brought by the owners of the Lowell and Dunmore patents against the Radio Corporation of America, the validity of these patents was sustained by the lower court and the case is now on appeal.

If the owners of these patents continue to be successful in this case, an immediate question for manufacturers of receiving sets not licensed thereunder, will arise as to whether or not the construction of past models embodied these inventions and if so what royalties or infringement damages must be paid for sets already manufactured and whether licenses would be granted by the owners on reasonable terms for the inventions covered thereby or refused or whether future models could be so constructed as to circumvent them.

In the suit brought by the United States of America against the owners of the Lowell and Dunmore patents, the United States claims to be the owner of these patents by reason of the employment in government offices of the inventors thereof at the time of the discovery of the inventions.

If the United States shall be successful in this case, a new owner comes into the field and we are interested as to what attitude it will take toward licensing the industry and whether it will make an effort to collect royalties from us or will the United States make the patents free for use by the industry without claim for damages for past infringements or royalties for the future.

Loudspeaker Patents

Other cases have been decided or are now pending, involving loud speaker patents, reports of which have been made by the Patents Committee of the Radio Manufacturers Association.

With reference to the patents held by owners involved in these suits and the patents held by other groups such as the Hazeltine Corporation which controls patents for Neutrodyne Circuit and the Jones Technidyne which has a patented circuit and the Lektophone and Magnavox which have loud speaker patents and the R. F. Laboratories which have set patents and the Dubilier which has patents for power supply and condenser equipment and the patents held by a number of smaller groups with one or more patents, and new claims arising and new patents being allowed, we seem to be on the threshold where important executives of patent holding companies and of radio manufacturers must find a sane solution for the industry if disastrous and expensive litigation and intense legislative effort is to be avoided.

e also report of Grigsby-Grunow suit against RCA group, June 27, for $30,000,000 damages. Page 164 of this issue.

An output meter for testing radio receivers

By C. J. FRANKS

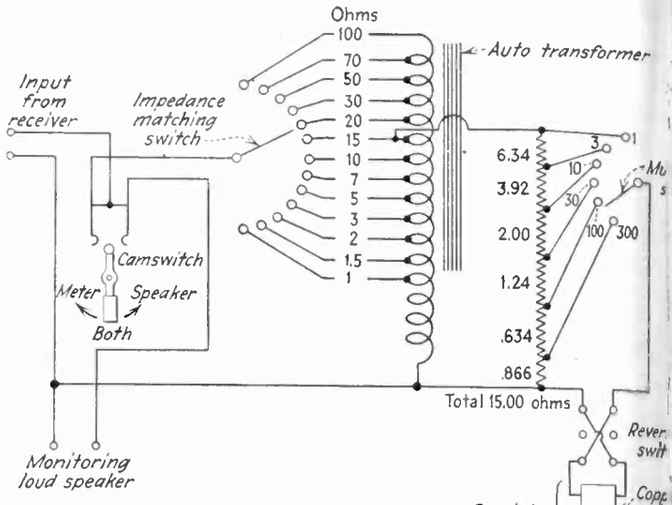
Engineering Department,
Radio Frequency Laboratories, Inc.

THE device to be described is a simple type of wattmeter suitable for measuring the power output of radio receivers. The novel features are (1) an input impedance adjustable to match output transformer impedances of from 1 to 100 ohms, (2) a meter having a linear scale and reading directly in milliwatts (3) a multiplier for extending the range of this meter and (4) a switch for connecting the set under test to the measuring device, to a loud speaker or both. These features will be discussed in the order mentioned. The device may also be set for an indicating device for the purpose of measuring sensitivity and selectivity of the broadcast receiver. The frequency characteristics of the transformer and rectifier are such as to make the device unsuitable for fidelity measurements.

The circuit diagram sufficiently explains the method of measurement which is the familiar one of feeding the output of the set to a load resistance and measuring the voltage produced across the resistor. A tapped auto-transformer is used to transfer this 15-ohm load resistance to any resistance between 1 and 100 ohms, the steps being chosen so as to give an almost constant percentage change of impedance over the range covered. Each step presents approximately 150 per cent of the impedance of the next lower step.

Construction of the transformer

A very special design for the auto-transformer was made necessary by the fact that the resistance of the transformer windings is added to the load resistance and therefore appears in the total impedance presented to the set output. However, this added resistance does *not* appear in the metering resistance and the meter therefore does not indicate the additional power lost in this transformer resistance, which thus becomes a source of error. If this error were constant with the position of the input tap, it could be compensated in the final calibration of the meter, and it was in an endeavor to obtain this constant percentage loss that the peculiar



Wiring diagram of output meter for radio receiver testing

transformer construction described below was resorte

The transformer winding has a total of 600 t wound on a shell-type core 1.125 in. x 1.125 in. in c section and having a winding space 1.625 in. long. wire size of the winding was graduated as follows

	Wind	60	turns	No.	18	Enamel	and	bring	out	Tap	No.
Continue winding		14	"	"	"	"	"	"	"	"	"	2
"	"	11	"	"	"	"	"	"	"	"	"	3
"	"	19	"	"	20	"	"	"	"	"	"	4
"	"	31	"	"	"	"	"	"	"	"	"	5
"	"	24	"	"	22	"	"	"	"	"	"	6
"	"	31	"	"	"	"	"	"	"	"	"	7
"	"	42	"	"	24	"	"	"	"	"	"	8
"	"	37	"	"	"	"	"	"	"	"	"	9
"	"	60	"	"	26	"	"	"	"	"	"	10
"	"	96	"	"	"	"	"	"	"	"	"	11
"	"	75	"	"	28	"	"	"	"	"	"	12
"	"	100	"	"	"	"	"	"	"	"	"	12

The result of this method of winding is that resistance of each section approximates a constant centage of the nominal impedance of the tap, introducing an approximately constant percentage e which can be compensated in calibrating the meter.

Method of measurement

The alternating voltage across the 15-ohm load res (or some portion of it) is measured by means of an a nating-current voltmeter. This consists of a Ge Radio copper oxide rectifier and a Weston Model

Appearance of the completed output meter

current meter having a range of 0–200 micro-s. This combination, when working out of a low ce source like the 15-ohm load resistor, has a e which is almost exactly proportional to the of the applied voltage. Since the power dis- in the load resistor is also proportional to the of the voltage across it, the watt scale on the s very nearly linear. The sensitivity is such that he rectifier is connected across the entire load ce (multiplier switch on point 1) full scale deflec- presents about 50 milliwatts. This enables as low as 10 milliwatts to be read.

range of the meter is extended by tapping the sistor in such a way as to give convenient power ving ratios as shown in the diagram. The maxi- leflection accordingly represents 50, 150, 500, 5,000, or 15,000 milliwatts, depending upon the of the multiplier switch. This should cover he range of powers encountered in testing modern es.

m switch is provided on the panel and so con- hat either the load resistance or the loud speaker connected to the set. Both are connected when tch is in the neutral position. This connection l in aligning receivers, the combination of sight nd permitting the adjustments to be made as as with sound and as accurately as with sight.

Limitations of the apparatus

in inherent limitations must be taken into account sing the device. The most serious is that the cy characteristics of the transformer and of the oxide rectifier both show a decided drop in e as the frequency is raised. This error may 0 per cent at 2,000 cycles and as much as 50 at 4,000. Added to this is the necessity of g voltage ratios from the watt readings by a ion, which involves curves of the impedance vs. cy characteristic of the transformer used in the In the transformer used in the model shown, the npedance at 7,000 cycles averaged about 150 per the impedance at 60 or 400 cycles.

The second limitation is one of accuracy. While the loss introduced by the transformer has been made as small and constant as possible there is still some variation between taps and this cannot be compensated in the calibration of the meter. This error may be as large as plus or minus 10 per cent. Should the improvement be considered to justify the cost this error may be eliminated by making the transformer with two windings and placing a resistor in series with each tap. These resistors can be so adjusted as to make the loss a constant percentage of the tap impedance.

Errors may be introduced by changes in the calibration of the output voltmeter. The copper oxide rectifier was chosen because of its ruggedness. With an input of 10 watts it is possible, without any serious damage, to turn the multiplier switch to point 1, thus overloading the meter by more than 100 to 1. This insures against burnouts by surges due to loose connections and the like but such overloads have been found to produce permanent changes in calibration which may be as large as 10 per cent.

Effect of harmonics

The copper oxide rectifier unit is of the bridge type and should not be affected by the presence of even harmonics in the wave being measured. None of the rectified units tested have been found to be perfectly balanced and for this reason a reversing key has been included in the circuit. When measuring a badly distorted wave, such as is obtained during overload of the receiver, the connections to the rectified are reversed by means of this switch and an average reading taken.

The range of input impedances covers only those usually found in the voice coils of dynamic loud speakers. To use the meter with receivers having the output transformer mounted in the speaker it is necessary to disconnect the secondary of this transformer from the voice coil and to run out leads to the meter. It is not possible to use the meter as it stands with a receiver intended to work into a "magnetic" speaker, except by the use of an auxiliary transformer whose characteristics must be known and considered in the final result.

▼ ▼ ▼

WE ARE ONLY FINDING OUT WHAT ALREADY EXISTS

Only a few of the paths to truth have yet been traversed and who can predict what the future may have in store.

For observe that with all our investigations and inquiries we are not creating anything.

We are only finding out what already exists—facts of which mankind must take account if it is to survive.

OWEN D. YOUNG

Tubes in chemistry

[*Continued from page 168*]

orange of the spectrum but to the additive effect of the red and yellow intensities on the human eye. These color transmission bands vary definitely for a given indicator. Fig. 7 shows the yellow transmission of a typical indicator which changes from yellow to blue with a decrease in acidity as "seen" by the photo-electric cell. Although varying for different conditions it may be generally stated that photo-electric cell methods using one stage of vacuum tube amplification and a milliammeter as the indicating instrument exceed visual precision by about ten times.

For indicators which give different shades of blue and violet where the sensitivity of the eye is poor much greater improvement is noted. The accompanying visual accuracy curve gives a fair comparison. Small quantities of metals which have colored compounds may also be analyzed rapidly and accurately by colorimetric methods using the photo-electric cell. Among these are: nickel, cobalt iron, manganese, copper, chromium, vanadium, uranium, tungsten, carbon, aluminum, and the rare earths. In organic chemistry such processes as nitrations, brominations and chlorinations may be followed and controlled. The hardness of water or its chlorine content may be continually checked. Another class of very important operations which may be followed or controlled automatically includes titrations—one of the most common operations in the analytical laboratory. Not only does the photo-electric cell judge the endpoint of the titration more accurately than does the eye but it can cause a relay to stop the flow of standard titrating liquid at any predetermined color value for the solution being analyzed. For a number of types of work like television and sound picture reproduction the common practice is to operate the cell at ten volts or so below its glow potential for maximum light intensity. In two instances only can this method be employed in photometry. One deliberately uses the photo-electric cell itself as a gas discharge tube in the common neon tube oscillator circuit and the other is in circuits where the cell is used as a null instrument. Great sensitivity for small light values is claimed for the first scheme. The second method has the great advantage that, when properly employed, the method becomes independent of light source fluctuations, absolute cell characteristics and changes in these characteristics.

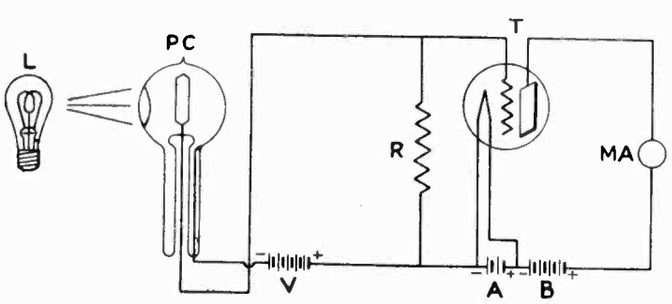


Fig. 9—Substitution of amplifier tube and meter for galvanometer of Fig. 8

As in ordinary electrical measurements, we have two types of light measurements. One involves the intensity of light and may be compared with potential measurements and the other is concerned with the quantity of light received by the cell over a period of time. This is similar to the familiar ampere-hour measurements in storage battery work. Light absorbed during a ... chemical reaction, during therapeutic treatment an... daylight recording are examples of this type and i... the use of some form of coulometer. Colori... measurements and control are concerned mainly ... the former class, i.e., intensity measurements.

If in place of the galvanometer of Fig. 8 we ... a resistance of fifty megohms, the IR drop acros... resistor will be proportional to the photo-electric c... and in turn, to the light intensity. If this is coup... a properly biased vacuum tube as shown in Fig. ... have a circuit capable of measuring "colors." ... proper selection of tubes and circuit constants, th... put milliammeter readings will be proportional t... color value of the solution being measured. A ... flexible arrangement results if we measure the IR ... across the photo-electric circuit resistor by means ... vacuum tube voltmeter of the type previously ... tioned (Fig. 5). Further advantage is gained in ... constancy of tube characteristics and batteries over ... periods is not a requisite for accuracy. Fig. 10 ... trates a simple outfit of this sort. A potassium hy... cell and a 120 type tube are employed. The entir... paratus operates from the batteries shown and ... measurements which are reproducible to about 0.... cent. Calipered measuring tubes are required in ... that the tube alone may not cause an error greater ... this.

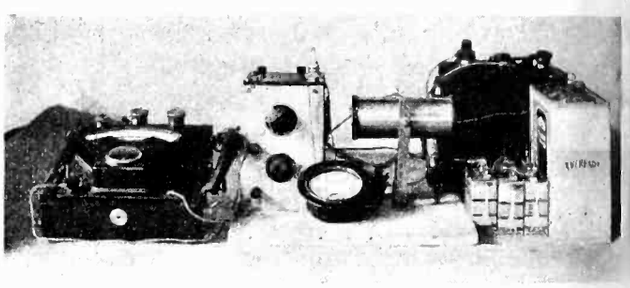


Fig. 10—Apparatus for colorimetric measurements as used in a chemical laboratory

A modification and extension of the colorimeter ... ciple is found in the apparatus for automatically ... forming analyses. A simple circuit for this purpo... sults when the milliammeter of Fig. 9 has been re... by a relay which operates a valve to stop the infl... titrating fluid. It is simply required to decide upo... color value of the solution at which the operation ... be stopped and set the relay to operate at this ... The unknown solution is placed in the apparatu... then the stirrer and titrating liquid flow are starte... the "endpoint" the stirrer and standard solutio... automatically stopped and a bell calls the attenti... the operator to this fact. Apparatus shown in the ... graph and modifications of it have been in successf... eration at New York University for three years. ... particular apparatus shown is designed for operati... 115 volt d.c. line supply. In localities where the v... fluctuation is considerable, battery operation be... necessary.

Many considerations such as light filter sel... choice of photo-electric cell according to characte... schemes for simplification and rather uncommo... important applications have necessarily been ... treated or omitted, but it is hoped that enough ha... said to enable those interested in electronics to ... ize the countless number of its applications in one ... greatest fields of science and industry.

he sound-picture industry abroad

By Dr. F. S. IRBY

Associate Editor, Electronics

HE table below gives some of the pertinent facts concerning the sound motion-picture industry abroad, at the end of 1929. During 1930, rapid s have been made in sound-picture installation in rincipal foreign countries. In Germany, it is esti- that 500 theaters had been equipped with sound-ducing apparatus up to June 1, 1930, while only ere so equipped at the end of 1929. This, how- represents only 10 per cent of the total theaters ing daily in Germany, and is an approximate per- ge of sound installation in other European states. e number of sound studios abroad totaled 24 at the f 1929, for which 48 recording sets were employed. ese, 25 were of American manufacture, and 23 n recorders. European producers were slow in g production of sound film, which gave American dcers an excellent start. Language barriers are, ver, presenting a serious handicap to English dia- pictures in continental Europe, now that the novelty and films have passed. It can be stated, however, he silent film has been definitely relegated to the kround, and that the sound synchronization is ac- ble only when a "super-film" is shown. German lque films are in greatest demand in Germany, Czechoslovakia, Austria and Hungary. They are also very popular in Poland, Yugoslavia and Rumania, even though German is not the first tongue in the latter states. It is thus seen that future exploitation of American films in certain European states will be difficult for the future. An answer to this problem is contemplated by American producers rapidly developing plans for the production of foreign-language pictures in their own European studios.

The increase in exports of some 60,000,000 linear feet of positive film in 1929, over the previous year, is accounted for by the popularity and demand for American sound film in English speaking countries. This was also due to the lack of sound film producing facilities in Great Britain. The latter country, however, is making rapid strides in sound pictures, with production plans calling for about 75 in 1930, as against only 16 in 1929.

In the Scandinavian countries, American sound films have been fairly popular, as in the larger cities a surprisingly large number of people are able to understand sufficient English to enjoy American dialogue, if it is not too idiomatic.

One result of the introduction of American sound films has been the increase in the interest and study of foreign languages, particularly English.

	Number of Theatres	Theatres Wired for Sound at End of 1929	Number Theatres Built in 1929	Number of Sound Studios at End of 1929	Number Sound Pictures Produced in 1929	Total Silent and Sound Pictures Produced 1929
MANY	5,266	223	123	2	90	282
T BRITAIN	4,426	980	171	10	16	50
NCE	3,113	166	20	5	4	52
AY	2,405	51	1	1	0	4
SIA	2,131	2	*	2	12	132 Features 115 Educa'nal
N	2,074	25	10	1	3	20
CHOSLOVAKIA	1,200	15	50	..	0	19 Features 383 Newsreel
DEN	1,182	45	7	..	0	12
ND	750	8	0	1	0	12
STRIA	736	23	0	1	0	19 Features 160 Shorts
GIUM	700	24	10	..	1	5
GARY	495	19	0	..	0	4
OSLAVIA	397	13	6	..	0	0
IANIA	357	4	4	..	0	4
TZERLAND	302	25	10	..	0	2
LAND	297	4	5	..	0	30 Educa'nal
MARK	270	20	0	1	2	4
LAND	236	57	7	..	0	2
ECE	224	6	1	..	0	2
WAY	212	8	1	..	0	3
GARIA	136	0	1	..	0	4
TUGAL	130	0	6	..	0	3 Feature 235 Newsreel
KEY	104	2	4	..	0	1
VIA	69	2	0	..	0	2
ONIA	60	1	2	..	0	4
HUANIA	45	1	1	..	0	0
TOTALS	27,317	1,724	440	24	128	1,565
IN AMERICA	4,402	300	*	..	0	Neglible
R EAST	4,000	400	Est. 40	..	0	5
ITED STATES	22,624	9,000	500	..	800 1,000 150 *	856 Features 1,104 Shorts 174 Serials * Newsreels

*Figures not obtained.

electronics

McGraw-Hill Publishing Company, Inc.
Tenth Avenue at 36th Street
New York City

O. H. CALDWELL, *Editor*

Volume 1 — JULY, 1930 — Number 4

Sound-track on color films

COLOR film, which has heretofore been generally released with sound synchronization supplied by disk, has raised new and complex problems when the sound track is added to such film. With the increasing use of sound-on-film and the drawing away from sound-on-disk, greater pressure will undoubtedly bring out new solutions for a sound track on color film.

The addition of the sound track to color film of standard 35mm. width, with the resulting loss in picture area, has decreased the screen intensity for color films to a greater extent than for black and white. A successful solution of this problem is offered in the increased picture area of wide film and may be an important reason for the latter's adoption.

Color standardization and definition

THE increasing interest and demand for color in the home, wherein orderly methods of color standardization may be obtained to make available harmonious colors in various pieces of household equipment, has opened up a new field for photo-electric measuring devices.

To properly evaluate the color characteristics of a material, one must not only have an accurate analysis of the spectral composition of the color, but also its degree of saturation or shade. Whether a material is transparent, translucent or opaque also must be considered and likewise its surface reflection characteristics, before any true in its color value can be determined.

Color is an individual human concept and fore subject to as many gradations as the people. The average human eye responds to waves varying in length from about 420 microns to about 700 millimicrons. The wavelengths cause a concept of violet, and a waves increase in length, the concept transi visually imperceptible gradations through green, yellow and orange to red.

The technologist recognizes about 280 colors in the visible spectrum. By varying th tensity of these pure colors, we can obtai almost unlimited number of colors and shades

It has been suggested that probably every sonable human desire for color variety coul satisfied by not more than fourteen pure co divided by 20 millimicron intervals across visible spectrum. Also, under ordinary ligh conditions, probably the variety in shade coul satisfied by not more than 10 varying degree saturation. This would give ten shades for of fourteen colors, or a total of 140 colors shades, compared with the infinitely large nu that are theoretically possible.

In matching and producing colors under above requirements, various photo-electric de are available, so that errors inherent to v observation are entirely eliminated.

Matter—Is it crystallized energy

SCIENTISTS wax and wane in their opin regarding the ultimate tapping and harnes of subatomic energy. At the World Power ference in Berlin, Sir Arthur Eddington, Br astronomer, dangled the hope before assem engineers that future 100,000 kilowatt genera would be run by a teacup of water per year. less a scientist than Sir William Bragg is of opinion that "atom energy will supply our fu need. A thousand years may pass—or tomo might see us with the reins in our hands."

Such hopes for our ultimate release from bondage of coal or water power or other mun sources of energy lie in the Einstein theory each bit of mass has an energy equivalent, and when mass is destroyed, energy is liberated. sun is the most prolific emitter of energy in

n; every second it radiates enough heat to he temperature of a quintillion tons of water its freezing point to its boiling point. As a of this prodigal broadcasting of energy the ses each second about four million tons of —a loss of about a trillionth part of itself years.

s loss of mass in favor of radiation goes on radioactive compounds, and in the mutual lation of electrons and protons in the al furnaces, the stars. Somewhere in the se—the evidence is not clear on this matter reverse process may be going on, so that there are holes in the universe through rediation escapes the system may not run as the pessimists among scientists claim.

a we tap this energy source?

And now—tone control!

ONE control was the most evident technical lea at the Trade Show of the Radio Manuers Association in June. The idea briefly ompensate the bad acoustics of a room in ich the radio is to be used; to enable the er to suit the tone of his music to his mood; ut out a certain amount of static in bad reig conditions, etc.

Most of the advantages put forward for tone ol are sales talk; the disadvantage is evident esigning and building an amplifier with a num of distortion only to turn it loose on the er with a device enabling him to adjust the ace of high and low frequencies without reto what the composer or orchestra director es.

the tone control can make up deficiencies in acoustics, and in times of static can so rethe unwanted noise that speech can be under-, the devices will be worth while.

he problem remains of translating Toscanini a full orchestra playing in a large auditorium, f a Goldman band concert in the vast expanse entral Park to the confines of a small room re the acoustics are radically different, and be very bad.

resent day receivers are still deficient in both and high frequencies; the big problem seems to reduce the tones below 100 or above 2500 es but to reinforce them.

The automatic stop worked!

THE desirability of automatic train stops has long been a subject of contention among signal engineers and railroad executives. But there can be no question as to the value of the automatic stop in one case just experienced by a middlewest railroad, where a locomotive "ran wild," last month.

Both the fireman and the engineer had been called from the cab to attend to some matters in the station. In their absence, a leaky throttle started the locomotive off,—slowly at first,—and then the jarring, as the engine lumbered up the track, kicked the steam-valve open further. As the engineer crossed the platform he looked up, to see his locomotive, a quarter-mile away, roaring along driverless at thirty miles an hour, and gaining speed every minute.

Fifty miles away a passenger train was coming on that track, and this wild locomotive was headed directly at it!

The engineer thought quickly. Rushing back into the station he telephoned the next signal junction, the automatic track stops were set, and when the fugitive thundered past, the track coils and vacuum tubes did their work and the engine came to a sudden and grinding stop!

We must produce foreign-language films, too

THREE of the problems facing the American film industry in foreign countries today are: patent litigations, language barriers, and legislation inimicable to the film exporter. In facing this situation, the production of foreign-language films by American producers, to compete with European production, will prove the key to continued profit in Continental markets.

There seems to be no doubt in the minds of European film leaders that American producers can supply satisfactory sound fiims for foreign audiences. But the question of production costs, considering the limited outlet for such films, will first have to be worked out on an experimental basis.

REVIEW OF ELECTRONIC LITERATUR

HERE AND ABROAD

On the cathode dark space in the Geissler discharge

[E. C. CHILDS.] The increasing commercial importance of gaseous-discharge tubes of all types warrants a critical review and analysis of the phenomena involved. The experiment described in this paper develops the voltage-current relation which subsists in the Crookes dark space, under various conditions. — *Philosophical Magazine, London, April, 1930.*

✦

Radio "buoying" of aerodromes

[LABADIE.] Two conductors circling the landing-field, on four-meter poles, carry an oscillatory current, reversed at an audible frequency. Reception on a loop antenna pivoted around a vertical axis gives the direction of the center of the field (by minimum signals): reception on a combination of horizontal loop and fixed antenna indicates whether the plane is without or within the circle and later when approaching the ground indicates the moment of arrival at the level of the wires.—*Science et la Vie, May, 1930.*

✦

Radio-seismograph

[GÜNTHER.] Description of an apparatus based on a condenser, the plates of which are respectively attached to a heavy pendulum and to a concrete base embedded in the earth, and which is connected between grid and filament of an oscillating tube so that infinitesimal variations in capacity produce changes in the heterodyne note produced with another oscillator. *Radio B.F.f.A., May, 1930.*

✦

A new system of television

[BRUN.] The system, which is described very fully, with numerous constructional and mechanical diagrams, is chiefly interesting for the use of two scanning-disks, co-axial, one with 21 radial slots and the other with 21 slots inclined at 45 degrees to the radii. These revolve at unequal velocities, in the ratio 11 to 12, and the scanning beam is thus made to travel over the object. Synchronism is obtained from electric clocks, no synchronizing signal being transmitted. The system is specially adapted to telecinematography.—*T.S.F. pour Tous, N° 65, "May," 1930, published June 1.*

Volume control

[SCHRAMM.] Useful summary of most present-day methods of volume control in radio receivers, both hand operated and automatic, with curves and theoretical explanations, especially of the latter. Among these are methods using auxiliary tubes controlling the plate voltage of the radio frequency amplifier, controlling their grid potential, or acting as damping resistances across an oscillatory circuit. One method (suitable for power detection only) is given, which needs no extra tube.—*Funk, Berlin, May 9, 1930.*

✦

Masses of the proton and electron

[H. T. FLINT.] The new quantum theory indicates that relations exist between certain physical quantities which have hereto been regarded as independent. This has led to a search for these relations and we have as a notable example Eddington's attempt to express the fundamental charge in terms of Planck's constant (h) and the velocity of light (c).

One of the most interesting and puzzling things in atomic physics is the asymmetry with regard to mass in the case of proton and electron. The question is, why is the mass associated with a positive charge $\frac{e+}{M_o}$ so widely different from that associated with a negative charge $\frac{e-}{m_o}$?

The author takes up this problem from his previously principle of "minimum proper time" and derives a theoretical background for the experimental relation $\frac{M_o}{m_o} = 1840$. He then takes up the same problem from the point of view of DeBroglie's wave mechanics.—*British Physical Society, April, 1930.*

✦

Emission from target bombarded with positive ions

[W. GEER AND C. L. UTTERBACK.] Metal targets have been bombarded by positive ions whose energies varied from 200 to 750 volts, while the characteristics of the electron emission were studied. The secondary emission and positive ion currents were measured by galvanometers of sensitivities 8.10^{-11} amperes and 6.10^{-10} amperes, respectively. The secondary emission been found to depend upon the pre treatment of the target, especial regard to the kind and amount o absorbed and to the duration o bombardment. These studies were with positive ion currents as lo 3.10^{-9} amperes, which is a smaller rent than has been thertofore us this connection. — *Bulletin Am Physical Society, June 6, 1930.*

✦

A new synchronizing syste

[BRAMI.] In order to provide a chronizing signal, the original int of the scanning beam (i.e. indepe of the variations imposed on it b object scanned) is made to vary pe cally, increasing in intensity with traverse of the object by the bean decreasing to its original value d the next traverse. The resulting i at the receiver would thus be brilliant at one side than at the o this is corrected by the receiving s itself being shaded progressively d towards the "brilliant" side. *pour Tous. N° 65, "May," 1930, lished June 1.*

✦

Ship and shore telephony

[COL. SIR THOMAS PURVES.] Sh distance is overcome by:

(1) Use of longer waves for distances.

(2) Erecting sending station to shore.

This article, by the President British I.E.E., describes the mean methods employed to maintain munication between ship and sho the British Post Office service.—*L Electrician, April 25, May 2, 193*

✦

Effect of radio on carrier-pigeons

[CASAMAJOR.] An account of tests with over 300 birds, flying kilometers between two points within 100 meters of various mobile transmitters (40 watts i using wavelengths of 210 and 270 spark and 1,200 to 2,000 meters In addition, a 25 kw. (antenna) station, distant 3 and 6 km. respe from the two points, transmitte tinuously during the flights. Abs no effect was observed on the bir flight-times were normal.—*La June 1, 1930.*

intensity measurements ne Australian cast stations

CHERRY.] The author gives the ental data pertaining to the field- r distribution of three Australian st stations. From these data wing conclusions are drawn.

ry rapid attenuation of the sig- used by Australian forest areas. ective ground conductivity va- n 4 x 10^{-13} to .07 x 10^{-13} e.m.u. nger wavelengths give greater es beyond forest areas.

mmerfield's formula holds for transmission over sea water, miles.

e radiation efficiency of the examined ranges from 48 to 60

uthor describes a type of ther- voltmeter using a "floating" ich he claims is free from fre- error and absorbs no power te circuit to which it is con- . The accuracy of these state- s questioned in the discussion llowed the presentation of the hough the validity of the re- general is conceded.—*Proceed- Physical Society, London, April,*

✦

ire high ncy ammeter

FORTESCUE.] The author de- he construction and theory of an of the hot-wire type intended at any frequency up to 100 mil- cles per second. The working the instrument consists of a fine ong the axis of a concentric Expansion and contraction of e causes the movement of a which indicates the current flow- the circuit.—*Journal I.E.E., ad), May, 1930.*

✦

ograph pick-up design

SUTTON.] This article contains sults of several experimental commercial pick-ups, together sign data on the author's own The methods of test are quite us and the results are of interest the practical and the theoretical *Journal I.E.E., (England) May,*

✦

matically interrupted e oscillations

RADCLIFFE and L. G. VEDY.] A automatically interrupted triode ions is described which depends interaction between an oscillating circuit and a circuit containing a ear resistance and a time circuit The theory of the circuit is developed and tested experimentally by means of oscillograms. The theory of the rise and decay of currents in a circuit containing an inductanc and a non-linear resistance is dealt with in an appendix. — *Cambridge Philosophical Society, April, 1930.*

✦

The present-day position of television

[NOACK.] Full descriptions are given of the Telefunken (Karolus, Alexanderson) and Mihaly-Baird systems, with some notes on the new Zwarykin system. This continues from previous articles on the historical development (March) and on the general differences between the systems (April).—*Radio B.F.f.A., May and June, 1930.*

✦

TRANSLATING WORLD POWER CONFERENCE AT BERLIN

By means of separate head-phone circuits, the proceedings were simultaneously interpreted in English, German, French, Italian and other European languages, saving delays and enabling all of the 4,000 delegates to follow the sessions

✦

Modern receivers

A series of critical descriptions, with photographs and in many cases circuit diagrams, of German commercial receivers: valuable as indicating the technique favored through most of Central Europe. Diagrams are given for the Mende (neutralized triode, grid detector with regeneration, audio resistance-coupled, ditto transformer-coupled), Siemens, A.E.G. (both screen grid, grid detector with regeneration, two audio amplifiers resistance - coupled).—*Radio B.F.f.A., April and May, 1930.*

✦

Glow-lamp potentiometer

[NOACK.] Description of a new Lorenz product replacing the tapped resistance or multiplicity of series resistances normally used with mains-anode-voltage apparatus to give the various voltages required. Five electrodes within a gas-filled tube give — 70, 0, + 70, + 140 and + 140 volts, the first and last being supplied with the rectified and filtered a.c. from the transformer. The outstanding feature is that the voltage supplied by any given electrode is practically independent of the current taken, and that the grid potentials supplied (from a potentiometer connected between 0 and — 70) are absolutely independent of the anode currents. —*Radio B.F.f.A., June, 1930.*

✦

Automatic (anti-fading) volume control

[FUELGEN.] A system is described by which the polarization of the grid of the first radio-frequency tube is altered according to the strength of carrier-wave received, no extra control-tube being used with plate detection. For grid detection a control-tube is added; the following is worth quoting as showning the present situation in Germany: "Plate detection is however rarely used since it demands very considerable inputs and since regeneration works badly with it. The typical radio receiver is that using grid detection" (and regeneration, it may be added).—*Funk, 20, May 16, 1930; 21, May 23, 1930.*

✦

Scattering of electrons by gas molecules

[METTA C. GREEN.] An indirect study of the scattering of electrons by gas molecules was made by measuring electron absorption coefficients in an apparatus containing a Faraday cylinder of variable aperture. A straight path method was used in which electrons from an oxide-coated filament were given a desired acceleration and made to traverse a 7.5 cm. path to the collector. A retarding potential between the cylinder and its shield kept out all electrons which had suffered inelastic collisions as well as those which had been scattered outside of the collector opening. Measurements were made in argon, helium, hydrogen, and mercury vapor at accelerating potentials ranging from 11 to 196 volts.—*Bulletin American Physical Society, June 6, 1930.*

✦

Stability on the edge of oscillation

[GODFRIN.] A mathematical study of the conditions with grid detection and regeneration, given an explanation for certain cases of "fringe-howl" (audio-frequency oscillations on the edge of the self - oscillating condition). — *L'Onde Electrique, N° 100, "April," published May 24, 1930.*

Report of Radio Research Board

This article contains a résumé of the work of the British Radio Research Board in all fields of radio research but mainly in connection with atmospherics, wave propagation and direction finding. A description of Professor E. V. Appleton's method of studying the characteristics and effects of the Kennelly-Heaviside layer is included. Several types of radio direction finder are described of which the Adock, which eliminates the horizontally polarized component of the down-coming wave, the rotating-loop beacon and the cathode-ray type are given special prominence. Atmospherics are described as "Phenomena proceeding from an unknown source in an unknown direction, working intermittently at unforseeable times and conveying unintelligible information in an unknown way." The means and methods of studying these phenomena are described. —*Engineering, London, April 11, 1930.*

✦

Frequency stabilization of tube oscillations

[E. MALLETT.] The addition of series inductance to the plate circuit of tube oscillator results in the frequency of the oscillations generated being independent of fluctuations in the tube constants. — *Journal I.E.E., (England) May, 1930.*

✦

Electrical diathermy

[PECK.] An oscillatory current of about 2 kilocycles is used, of some 100 to 200 volts, the output being about 500 watts. One electrode is formed by a metal plate of about 1,000 square centimeters on which the patient lies, the other by a suitably shaped needle of inoxidizable steel. The circuit is essentially a single-tube oscillator, both filament and plate being spread with unfiltered a.c. from the mains through transformers; the oscillatory circuit is connected to the plate and the current fed to the two electrodes through a coupled coil. A point of special interest is that as the temperature produced is over 100 deg. centigrade, the water vapor generated tends to separate the flesh from the needle as the incision is made.—*LaNature, May 1, 1930.*

✦

The photo-electric cell and its applications

[DUNOYER.] Largely based on American practice, but describing also some French applications: a petrographic microscope for the study of the reflective power of minerals, a photo-colorimenter, the Bélin telephotography system, etc.—*Science et la Vie, June, 1930.*

Cathodes: their manufacture, properties and evolution

[RICQ.] This article, the first of a series, deals very fully with the properties and preparation of tungsten cathodes. The author is the Director of one of the principal French tube manufacturers, so that the information can be taken as representative of French practice. — *Radio - Electricitié, N° 75, June, 1930.*

✦

The Chireix-Mesny antenna and the France-Algeria telephonic system

[PIERRE.] Full descriptions of this beam service, antenna, transmitter and receiver are given.—*Radio Electricitié, N° 75, June, 1930.*

✦

Precision high frequency ammeter

[E. B. MOULLIN.] A dynamometer type with a geometrical form for which all changes of current distribution can be calculated. The correcting factors approach a limiting value and do not increase continuously with frequency as they do in thermal instruments. The instrument can be designed to carry unshunted a current of any magnitude and has been used for frequencies up to 30.000,000 cycles per second.

The meter consists of two conducting cylinders within a screen tube, one cylinder being movable with respect to the other. In the future it is proposed to use only one cylinder which will be placed eccentrically within the screen tube and to measure the repulsive force between the current in the cylinder and the eddy currents induced in the screen tube.—*Journal I.E.E., England, May, 1930.*

✦

Sunspots minima to improve radio reception

[HAROLD A. LAFOUNT.] Shows such transmission to be inversely correlated with solar activity. Nine years ago when radio broadcasting was just starting, we were in a minimum of solar activity, a sunspot minimum, and reception in the East from Western stations was at its maximum, explains Mr. Lafount, who is Radio Commissioner representing the West Coast.

For the several years past, however, sunspots have been passing through a maximum. Measurements made by Dr. Greenleaf Whittier Pickard at Newton Center, Mass., have shown low field values from Western stations, in consequence of which but slight heterodyne interference has existed between East and West coast stations. Scientists tell us we are now rapidly passing through the sunspot maximum or period, the result that field strength of Coast stations is increasing in the and an extrapolation of the cur dicates that within a year we shall have high field strength from W stations.—*United States Daily, Ju 1930.*

✦

Thermal phenomena in r

[HEMARDINQUER]. Summary o principal thermal effects used in R Fessenden's detector, Duddell th galvanometer, thermo-electric co for filament heating, and the new G "Tube Loud-speaker" in which the tron bombardments cause vibratio the anode, this forming part of the wall or being mechanically co thereto, and the sounds thus being audible.—*La Nature, May 15, 1930*

✦

X-rays produce new species

[F. K. RICHTMYER.] Among the important and fascinating of r developments in X-rays is the ap tion in the field of biology. The dent of evolution has always puzzled in his attempts to e how the different species of plant animals originated. If carefully se and fertilized corn be planted, the produces corn of the same kind a seed. Now and then, however, it pens that the offsprings of plant animals show differences from parent stock, the agency for prod which was not at all understood.

It has recently been found, how that seeds of plants and eggs of i exposed to X-ray radiation will de a very large number of progeny different in characteristics fro parents. Here, then, the biologis parently has at his disposal a labo method for producing new species. importance of this discovery can overestimated. Its bearing upo theory of evolution is obvious.

It has been suggested, for ex that perhaps the mutations in and animals which occur in nature been due to the action of cosmic on living matter. Quite apart fro importance of this discovery in logical theory, one can imagine t which the plant breeder, for ex will make of this new effect.—*J of the Franklin Institute, June, 1*

✦

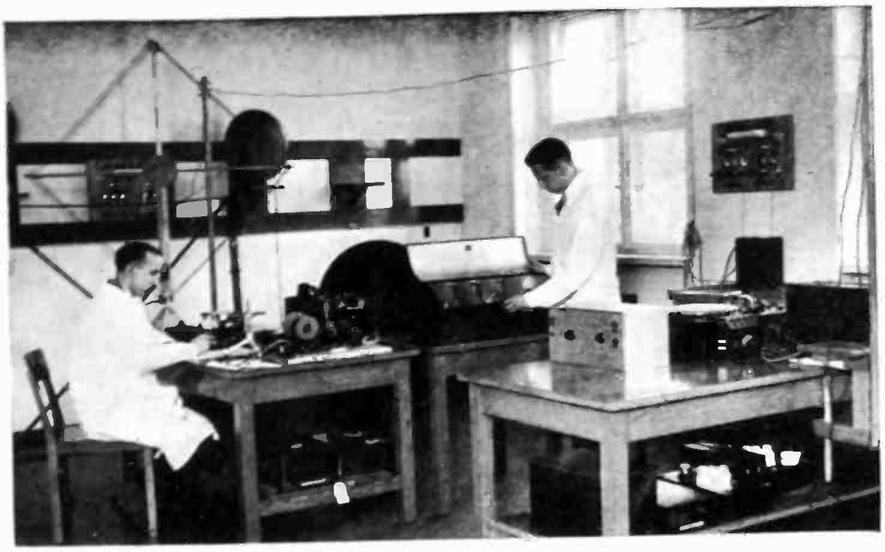
Short-wave adapter for broadcast receivers

[GEORGE GRAMMER.] Descriptio circuits of a short-wave converter can be plugged into standard a.c. cast receiver for listening to shor code and programs.—*Q S T, July*

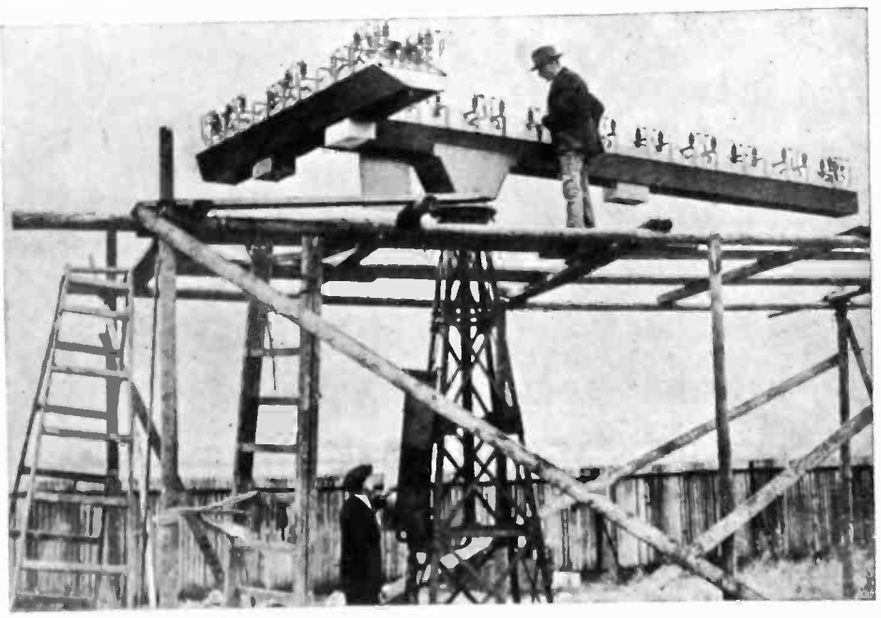
ectronics

verseas!

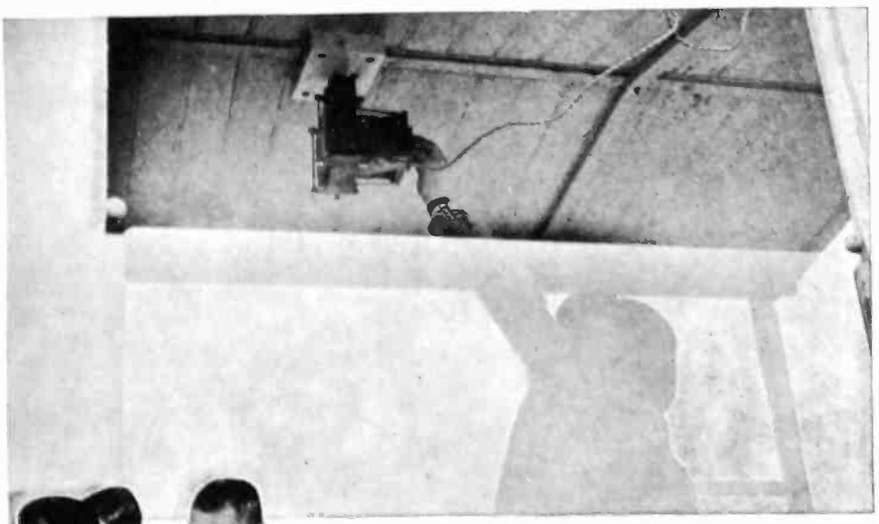
many, England, France
Japan are all working on
plications of the ubiquitous
um tube.



Above—A scene in the radio laboratory of the new Heinrich Hertz Institute near Berlin, Germany, where research is carried on along lines extending the work of the great pioneer of radio.



At right—A gas-filled glow-tube indicator at the Croyden flying field near London. The marker can be turned to show the direction of the wind for night landings.



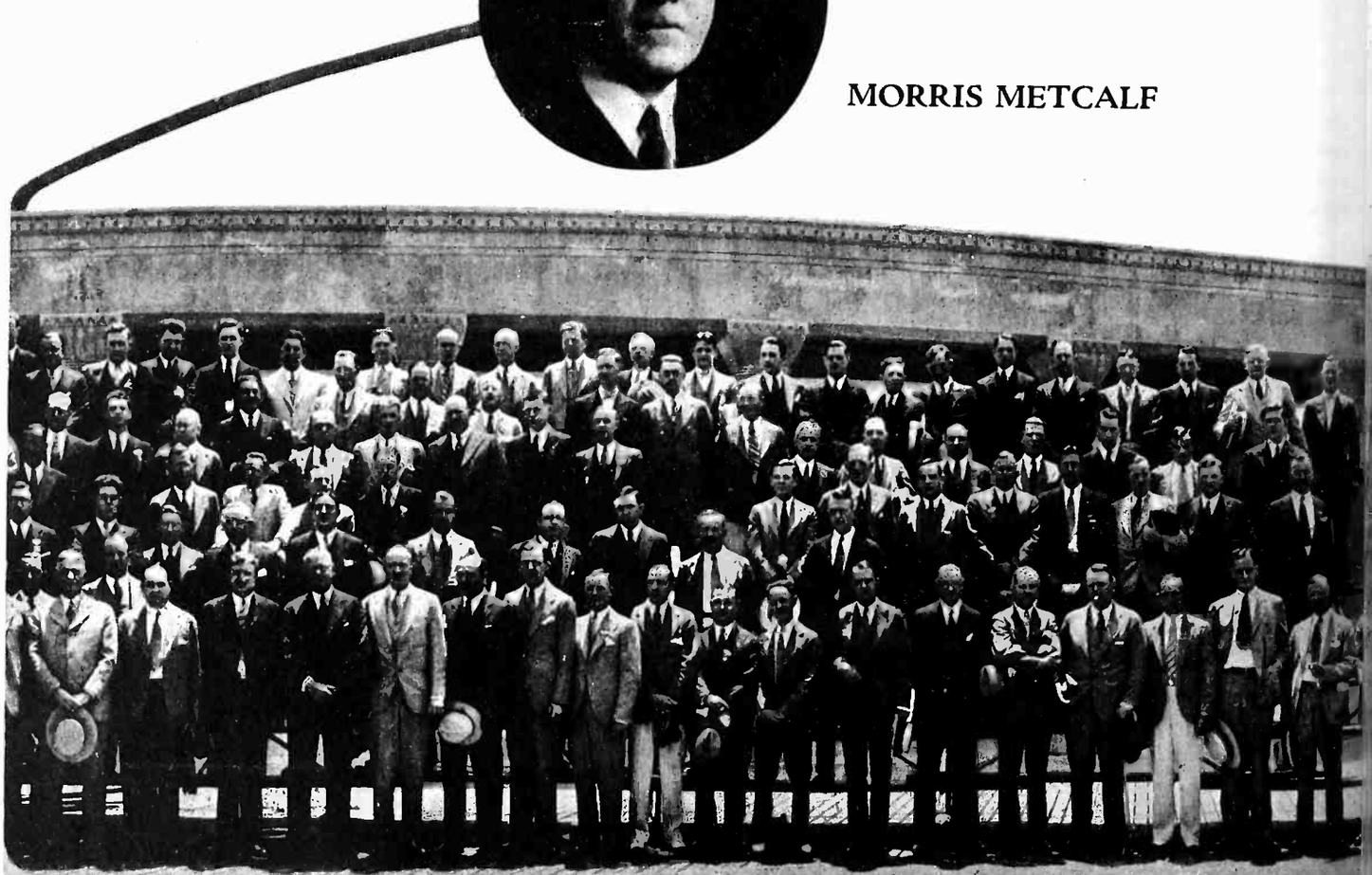
At right—How the horse racing results at Longchamps, near Paris, are definitely determined. A photo-cell operates this camera which takes a picture of the finish line just as the horses cross it.

At left—At the Tokio military college experiments are being made in operating pilotless tanks by short-wave control from behind the attacking lines.

RADIO MANUFACTURERS at Atlantic City

PRESIDENT-ELECT, RMA

MORRIS METCALF



THE Radio Manufacturers Association held its annual convention at Atlantic City, N. J., June 2 to 6, during the Trade Show, a report of which appears on pages 176 and 177.

Officers of the RMA for the year were elected as follows: President, Morris Metcalf, American Bosch Magneto Corporation; first vice-president, Joseph L. Ray, Corporation of America; second vice-president, I Erskine, Sylvania Products Company; third vice-pre Arthur L. Walsh, Thomas A. Edison, Inc.; tre E. N. Rauland, Rauland Corporation, Chicago. Geddes was re-elected executive vice-president.

NEWS
THE ELECTRON INDUSTRIES

one-third of America's s yet have radios

a convention of radio jobbers lers at Atlantic City, N. J., dur- Radio Trade Show, which June 7, O. H. Caldwell, editor nics," estimated that 1930 radio- sales will exceed 3,500,000 sets. presents about one 1930 pur- out of every five American which are still without radios. e 29,000,000 homes in America, 00 are now supplied with elec- but only 7,700,000 of these yet utilize modern alternating- radio sets. With 2,000,000 of these "wired" homes retain- battery sets, and the remaining 00 having no sets of any kind, pparent that 12,300,000 house- in wired homes are now wait- e sold modern electric radios. ring to the nine million homes yet have no electricity supply, six million of these are on . Two million three hundred d of these farmers have battery The 3,700,000 remaining farms me prospects for the new low- battery receivers. In addition re 2,000,000 unwired city and n homes without sets—a total of 00 immediate prospects for bat- ts.

▼

Bell & Howell Company is ex- g in Europe, according to J. H. b, president of the company, who y returned from a two months' s trip to study the conditions of vie industry in western and cen- urope. "The European markets lity products are especially favor- he states. Mr. McNabb announces rmation of the Filmo Company of d, located in Amsterdam, and the Company of Central Europe with uarters at Zurich, serving Bell & ll dealers in Germany, Switzerland, a and Belgium. The Bell & ll Company was established over rs ago. Its main offices and fac- re in Chicago. It recently com- a new building in Chicago which e devoted exclusively to research, iment and invention in connection the motion picture industry. Here a of motion picture engineers, under irection of A. S. Howell, are en- in working out important cine- graphical problems. The new struc- of more than 35,000 feet of floor , cost more than half a million rs.

The General Radio Company of Cambridge, Mass., is erecting a four-story building which will increase its plant capacity 60 per cent. This addition will be devoted largely to research laboratories and to special forms of production on radio-frequency apparatus for use in research laboratories. The consideration of a suitable site for this building disclosed the fact that testing methods have developed so rapidly that today it is no longer possible to set up a laboratory in any convenient place. Special facilities for the maintenance of frequency standards to an accuracy of two parts in ten million, were sought by the General Radio engineers in planning the new laboratories. Sensitivity readings must be reliable to closer than a microvolt. This precision work calls for laboratories so located and constructed as to render them free from external disturbances. The new building is being constructed with these and other considerations in mind.

Benjamin H. Price of the DeJur-Amsco Corporation, Fairbanks Building, New York City, has been on an extended tour to the Pacific Coast. During his trip Mr. Price introduced the new DeJur-Amsco variable condenser for the 1930-31 season. The DeJur-Amsco Corporation also make heavy-duty rheostats and potentiometers for use in talking movies and other photo-sound reproducing systems.

▼

FRED WILLIAMS

General sales manager of Raytheon occupies the center of this picture. Out for a ride with D. G. Raymond, manager of Raytheon's central division at Chicago, they stop to talk with a friend

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has appointed a scientific advisory board, made up of five leading scientists from the universities of the East and Middle West, which will confer with Westinghouse research engineers on scientific developments. The members are: S. M. Kintner, director of the laboratories; Dr. G. B. Waterhouse, head of the department of metallurgy at the Massachusetts Institute of Technology; Dr. Stephan Timoshenko, head of the school of advanced mechanics at the University of Michigan; Dr. Edward Mack, Jr., professor of physical chemistry, Ohio State University; Dr. P. W. Bridgman, head of the department of physics at Harvard University and Dr. C. E. Mendenhall, head of the department of physics at the University of Wisconsin.

The DeForest Radio Company, Passaic, N. J., announces the appointment of Charles A. Rice, former Sales Manager for the Champion Radio Works, Inc., as Eastern Sales Manager of the DeForest company. Mr. Rice is well known in radio trade circles. During the World War, he was a radio operator in the Navy, having served previously with the old Marconi Company. From 1922 to 1925, he was manager of the radio department of the Electric Appliance Company, Chicago. In 1925 he served as district sales manager of the DeForest Radio Company for the Chicago area, becoming assistant sales manager of that company and later Director of Sales, being most active in the Clause 9 litigation in behalf of the DeForest interests. During 1928, until recently, he was general sales and advertising manager of the Champion Radio Works.

The National Union Radio Corporation, 400 Madison Ave., New York City, announces that Dr. Ralph E. Myers has been elected vice-president and chief engineer of the company and has been elected to its board. Dr. Myers formerly was chief engineer in charge of research and development on lamps and radio tubes for the Westinghouse Lamp Company, Bloomfield, N. J., and was with Westinghouse for twenty-one years. He was one of the scientists who developed the 227 tube, was one of those developing the general line of oxide-coated filament tubes.

Five of his assistants at the Westinghouse Lamp Company accompany Dr. Myers to National Union. They are: Dr. Ernst A. Lederer, engineer; M. N. Fredenburgh, chemist; Frederick F. Wallen, plant superintendent; William M. Perkins and Charles E. Swiss. "Dr. Myers and his staff, which comprises some of the most brilliant workers in the radio tube research field, is being given every technical and plant facility for the production of a noteworthy line of products during 1930," declared E. A. Tracey, vice-president of the company in charge of sales. He is fifty years old. He is a member of the American Institute of Chemical Engineers, the American Institute of Electrical Engineers and other technical societies.

Acme Sound Products Corporation, 35 E. Wacker Drive, Chicago, is a new organization, combining motion-sound pictures, sound recording, portable sound and projector equipment and commercial photography. A. Leroy Fasick is vice-president.

✦ NEW PRODUCTS

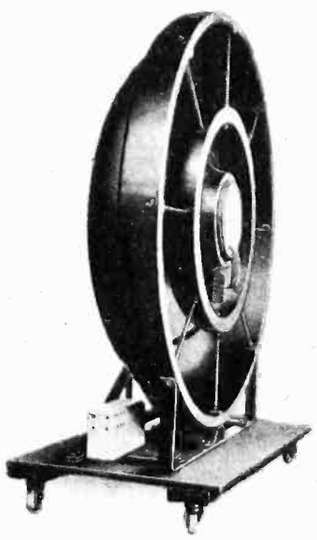
THE MANUFACTURERS OFF

This section is prepared by the editors of Electronics purely as a service to readers. Its aim is to present announcements of all new products, devices and materials of interest in the field of the paper. All items are published solely as news, and without any charge or any advertising consideration whatsoever.

✦

Uni-directional bowl speaker

BUILT in an outdoor and indoor model, the speaker illustrated is being marketed by the Operadio Company of St. Charles, Ill., and is known as the Uni-Directional Bowl Speaker. It is designed especially for theatre use, provision having been made for all the sound to emanate from the front,



thereby eliminating any echo in the rear. The unit functions as an electro-dynamic speaker at the front of the diaphragm, while the sound energy produced at the rear is expanded exponentially and reflected to the front through the full area of the speaker. This speaker has a diameter of five feet.—*Electronics, July, 1930.*

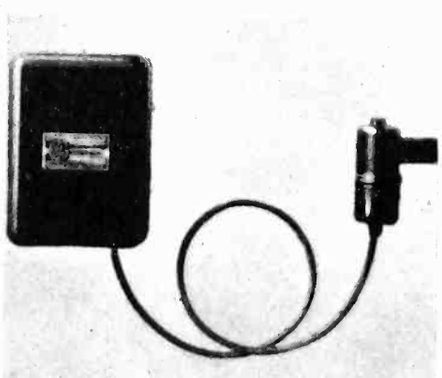
✦

Home televisor kit

FOR those desiring to build their own home radiovisor or television device, the Jenkins Television Corporation, 370 Claremont Ave., Jersey City, N. J., has introduced a kit of parts, ready to assemble. This kit includes all necessary components, completely machined, ready to be assembled and wired, with the single exception of the wooden pieces and bakelite panel for the platform on which the unit is mounted. The completed radiovisor consists of a motor control rheostat, television lamp house and a unique Faraday induction motor which drives the scanning disk at synchronous speed. The scanning disk is obtainable in the 48, 60, 24 and 45 hole types, with corresponding rotors for the desired number of pictures per second. This kit retails for $42.50, with $7.50 extra for the Jenkins television lamp not included in the kit assembly.—*Electronics, July, 1930.*

Photo-electric relay

FOR the operation of counters, control of mechanisms and for the starting and stopping of machinery, a compact photo-electric relay unit has been developed by the General Electric Company of Schenectady, N. Y. This unit known as the CR7505-A1 photo-electric relay is a device consisting of a photo-electric tube, a sensitive relay, a contactor, an amplifying tube and associated apparatus. The amplifying tube used is the G-E Pliotron Type. The contacts of the relay control the coil



circuit of the contactor. Four feet of flexible, rubber-covered conductor permit mounting of the photo-electric tube holder in small spaces around machinery, etc. This device may be used for a multiplicity of uses where a photo-electric operated relay is desired.—*Electronics, July, 1930.*

✦

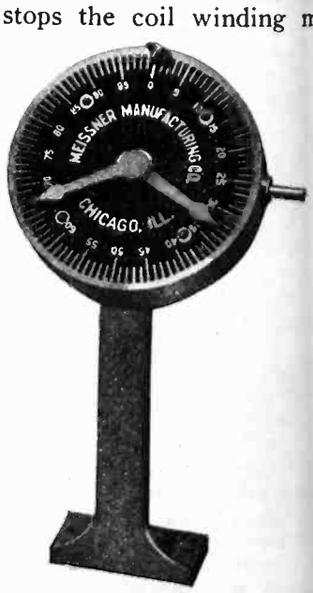
Aviation dynamotor

OPERATING in conjunction with the highest grade radio telephone or telegraph equipment, a new type aviation dynamotor for aircraft radio is being marketed by the Eclipse Aviation Corporation, East Orange, N. J. This is to be known as the Type A model and is especially designed for radio power of multi-engined transport and passenger planes. It has a rated output of 525 watts and is driven from a 12-volt battery. A four-bolt mounting base ables it to be installed at any p within the plane fuselage where length of cable to battery and radio would not be an obstruction. Re control and the use of a mini amount of heavy cable is obtaine designing the dynamotor to operat conjunction with the Eclipse switch. Completely shielded, the d motor and switch weigh 30½ lb.—*tronics, July, 1930.*

✦

Revolution counter

A NEW and improved revol counter is now being manufacture the Meissner Manufacturing Comp 522 South Clinton St., Chicago, This device counts from 0 to 10,00 from 10 to 100,000 revolutions, co ing for all practical purposes the plete range of coil winding. It ca equipped with a solenoid and mer switch mechanism to release a b which stops the coil winding mac



instantly. The counter can be se any required number of turns and the coil is wound to that numb turns, the revolution counter stop coil winding machine. — *Electr July, 1930.*

ors

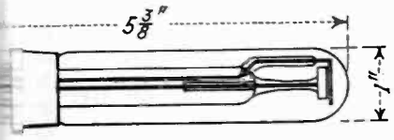
ED in construction, compact in eat in appearance and easily d, are some of the outstanding e of the new Super Davohm und resistance unit, recently

ed by the Daven Company, 158 St., Newark, N. J. It differs standard unit in various ways, h having been considerably de- nd the winding space increased, modate a heavier wire, insuring er safety factor.—*Electronics, 30.*

✦

recording tube

H B. ZETKA, 460 Bloomfield ontclair, N. J., has announced lamp for recording sound on he variable density method. The turer claims these new lamps able of recording upwards of eet of sound track. Duplication erical characteristics of these has been found feasible with are used at every stage of their ture. When operated at 550



ad 8 milliamperes, they require watts of heat dissipation which n found satisfactory in actual hen operated under these con- the permissible voltage swing is 00 volts peak, thus requiring a power from the amplifier of tree-tenths of a watt. The elec- in this lamp were selected for inimum tendency to vaporize operating conditions. — *Elec- July, 1930.*

✦

-wound tubular

sors

Polymet Manufacturing Corpora- 33 East 134th St., New York as announced a new line of wire- tubular resistors. These re- are supplied in single value units tapped units for use as voltage rs. They are supplied as stock in single value units up to 0 ohms resistance and 20 watts ation. For manufacturer's use, sual values and current capaci- re available on special order as ed.—*Electronics, July, 1930.*

Multimeters

AN IMPROVED multimeter has been announced by the Rawson Electrical Instrument Company, Cambridge 39, Massachusetts. The junior multimeter covers 12 different ranges. Readings from 1 microampere to 1 ampere (1,000,000 mics); 20 microvolts to 1,000 volts for direct current are possible. Three binding posts and one selector switch are provided. It is specially suitable for covering minimum and maximum readings on separately mounted thermocouples in vacuo for

high-frequency work. This company also specializes in a wide variety of a.c. and d.c. high-sensitivity meters.—*Electronics, July, 1930.*

✦

Power level indicator

TO MAINTAIN a careful check upon the signal amplitude at various points in voice transmission circuits, a device known as the Type 586 power level indicator is now being marketed by the General Radio Company, Cambridge, Mass. Its indicating element is a copper-oxide-rectifier voltmeter of 5,000 ohms impedance which is calibrated to read the power level in decibels. It is adjusted so that at mid-scale it reads zero level, 6 milliwatts when con-

nected across a 500-ohm line. The scale is graduated in steps of 2 decibels and covers a range from minus 10 to plus 6 decibels. This unit may be obtained in a cabinet model or for relay rack mounting as shown in the accompanying view. The price of the latter is $64.—*Electronics, July, 1930.*

✦

Volume control for talking pictures

SELECTION of three audible frequencies—low, medium and high is provided by the SAF-3 unit volume control brought out by the Triad Manufacturing Company of Pawtucket, R. I. The SAF-3 unit is a device which separates the sound into three channels, each of which can be controlled independently. The amount of correction is governed by means of a variable control knob.—*Electronics, July, 1930.*

✦

High vacuum pump

AMONG the pumps brought out by the Central Scientific Company, 460 East Ohio Street, Chicago, Ill., is the No. 10999 Cenco Hyvac pump. This is a high vacuum unit available for small volume work. Operating speed is 240 r.p.m.; driven by V-belt of molded rubber with core of impregnated cord; amount of oil required, 1 liter; free air capacity, 7 liters per minute; guaranteed vacuum, 1 micron. List price $90.—*Electronics, July, 1930.*

✦

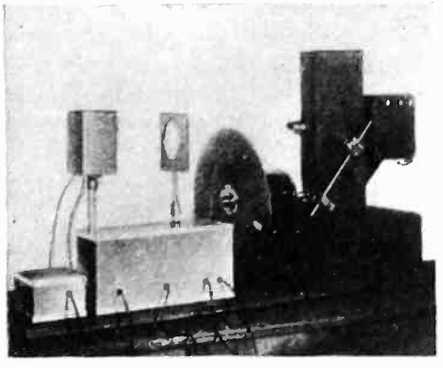
Automatic voltage regulator

AN automatic line voltage regulator device which may be plugged in between the usual attachment plug and the screw base plug has been announced by the Clarostat Manufacturing Company, 285 N. Sixth Street, Brooklyn, N. Y. This device varies its resistance in keeping with variations in the line voltage. Operation over a range of 106 to 145 volts maintains the applied voltage to the set within safe and satisfactory limits.—*Electronics, July, 1930.*

✦

Experimental television set

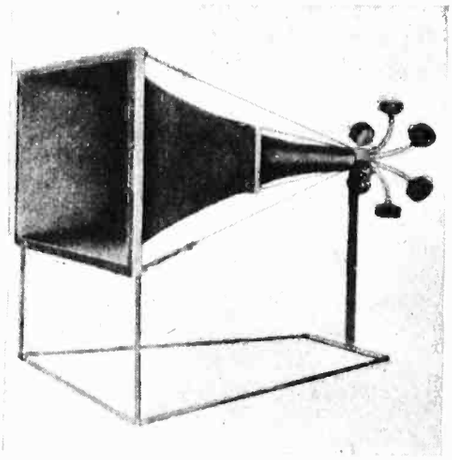
TO PROVIDE amateurs and experimenters with a complete television transmitter and receiver, the Insuline Corporation of America, 78 Cortlandt St., New York City, has brought out a complete unit selling under $300. This transmitter consists essentially of a motion picture projector, utilizing standard 35 mm. safety film. A synchronous motor operates the projector through a suitable gear reduction and



the same motor also operates a transmitting scanner. An optical focusing system is mounted in front of the reel housing, while a condensing lens focuses the scanned diverging rays into a photo-electric cell. Connections are made from the photo-electric cell to the receiver which consists of a four-stage, resistance-coupled amplifier, working into a neon lamp.—*Electronics, July, 1930.*

Super power horn for airports

PRODUCTION of an airport horn has been announced by the Macy Manufacturing Corporation, 1449 39th St., Brooklyn, N. Y. It is equipped with six independent, heavy duty re-



ceiving units, instead of a single dynamic unit which distinguishes it from the ordinary exponential loudspeaker. Although the air column is the same length as that of a horn of similar size having a single unit, six times the pressure is applied, thereby giving the new instrument six times the projection power. The device permits airport officials to issue orders to pilots and may also be used to reproduce musical programs.—*Electronics, July, 1930.*

✦

Armored bridge used in tube construction

COMPELLED by widespread demand to devise means to make a stronger and more durable product, the Cable Radio Tube Corporation, 84 North Ninth St., Brooklyn, N. Y., has developed a new feature called "Armored Bridge," which will shortly be embodied in Speed tubes. It is a scientifically designed shield or reinforcement, attached to the mica bridge, essential in tube construction. This provides for a shock-proof rigid mounting which eliminates damage in transit and rough handling.—*Electronics, July, 1930.*

✦

Auto ignition filterettes

THE Tobe Deutschmann Corporation, Canton, Mass., is manufacturing a new line of kits known as the Tobe Ignition Filterette Kits, the purpose of which is to prevent interference caused from the ignition while the car is running. These kits come boxed complete, containing the necessary units for four-, six- or eight-cylinder cars. All essential capacity and resistance is included. The prices range as follows: AK4—for 4-cylinder cars, $10; AK6—for 6-cylinder cars, $12.—*Electronics, July, 1930.*

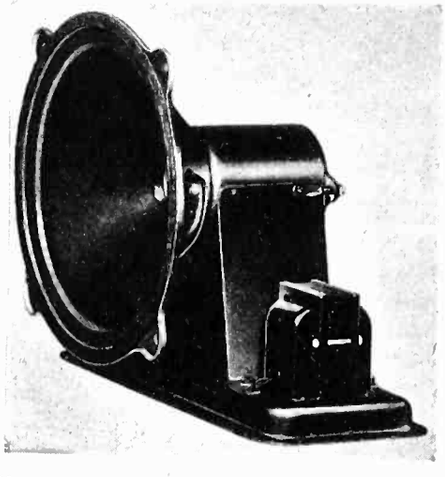
Waterproof diaphragm

STEVENS MFG. CORP., Newark, N. J., announces a new Burtex or impregnated cloth diaphragm. It is provided with a special waterproof finish and tests indicate that it can hold water for 50 hours without sign of leakage. The diaphragm is impervious to moisture, and is unaffected by heat, cold, salt air and other climatic conditions. It is considerably lighter than the Burtex diaphragms heretofore available, yet it can be made in any desired weight or stiffness to meet specific requirements.—*Electronics, July, 1930.*

✦

Concert dynamic speaker

THREE new electro-dynamic speaker units have been brought out by the Jensen Radio Manufacturing Corporation, 6601 South Laramie Ave., Chicago, Ill. The Jensen Auditorium Junior, which has a 10-in. cone, is a new addition to this company's line of speakers. It is intended primarily for theater and public address system installations. Ex-



cellent results have been reported in tests where a number of these units were mounted on a single large baffle board or upon individual baffles closely assembled. List prices for units are as follows: Jensen Concert $27.50 to $37.50; Jensen Auditorium $45 to $65; and Jensen Auditorium Junior $30 to $42.50.—*Electronics, July, 1930.*

✦

Microphones

FOR use in broadcasting stations and public address systems, a transverse current microphone has recently been announced by the Amplion Corporation of America, 133 West 21st Street, New York City. In this type of microphone, the current flows across the face, instead of in the conventional way. The current is forced across the face of the device by providing two carbon electrodes, located near the periphery of the diaphragm, diametrically opposite each other. Between these electrodes a shallow channel is cut and filled with a special type of granule.—*Electronics, July, 1930.*

Short-wave adapter

THE WorkRite Radio Cor 1812 East 30th St., Cleveland, C announced the Walker Flexi-Ur may be used as a short-wave for plugging into the detecto of a receiver. It is designed to with battery, eliminator or a.c. r Plug-in coils to cover a wave 15 to 550 meters are furnished unit. Suitable plugs are avai permit immediate and convenie nection of the unit to the tub of the receiver. This unit is a cast aluminum case for shielding and light weight. Th measures 5 in. by 7½ in. by 2½ weighs 2¼ pounds. List price, *Electronics, July, 1930.*

✦

Loud speaker

THE Wright-De Coster Compar of Saint Paul, Minn., has placed market the Wright-De Coster "7 speaker. The horn is mounte swivel and turn table and may b or lowered in any direction. Tl is made of thick, strong, non-r material, reinforced with met finished with water-proofing m Installed in the metal water-proo partment of the "75" speaker Model 107 chassis equipped water-proof cone. When operati unit with 15 to 30 watts, the ho be heard two to three miles. *tronics, July, 1930.*

✦

Phonograph pick-up

TWO new pick-ups have recentl brought out by the L. S. Gordo pany, 1800 Montrose Ave., C Ill., known as the CG-3 (witho ume control), and the CG-4 wh a volume control, mounted in th of the tone arm. These new p

feature the reduction of weight needle to four ounces, while still the actual pick-up head weigh enough to insure that the inertia head will not be overcome due to vibration. Smooth action of the it operates across the record is by a ball bearing rest at the sv *Electronics, July, 1930.*

PATENTS

IN THE FIELD OF ELECTRONICS

A list of patents (up to June 24) granted by the United States Patent Office, chosen by the editors of *Electronics* for their interest to workers in the fields of the radio, visio, audio and industrial applications of the vacuum tube

Acoustics

peaker. A combination of a ne actuated by an electro- device and a large horn. Roy roy, assigned to Paramount Lasky Corporation. No.

ype loud speaker. Lewis M. assigned to F. A. D. Andrea, 1,762,090.

a signal. A method of project- m of sound waves upward. J. ey, Washington, D. C., and . Nesbitt, Chevy Chase, Md. ,927.

speaker. A loud speaker, ap- of the push-pull electrostatic V. L. Hartley, assigned to Bell ce Laboratories, Inc. No.

vood loud speaker. A combina- parchment cone and a flexibly Balsa-wood sounding board, connected to the periphery of J. M. Hyde, Jr., assigned ins Corp., Jersey City. No.

dspeakers. A series of patents to Marcus E. Hopkins and as- Hopkins Corporation, or Ti- Corporation. These patents ound the use of a central rela- ht stiff diaphragm, surrounded ternal sounding board of greater No. 1,763,048, to No. 1,763,055,

id. Microphone and battery in ith a vibratory arm which is ween the deaf person's teeth. Phipps, Los Angeles, Cal. No.

ducing device. Several resona- th separate diaphragms and a tuating unit for the diaphragm. Plum, Jr., Oakhurst, New Jer- . 1,760,085.

ograph pick-up. An acoustic m formed of an alloy comprising m. Wm. A. Scheuch, assigned to o., Inc. No. 1,759,632.

ric phonograph. A pair of ele- having different electric conduc- and arranged to have a variable with each other, a vibratory r for opening one of such ele- to short-circuit a variable length of the element having the lower tivity. Adolph A. Thomas, New N. Y. No. 1,759,967.

d reproducer. A spiral diaphragm its convolutions in edge-wise n, and a means for imparting ons to an end of the spiral. Ed- Smythe, assigned to W. E. Com- Inc. No. 1,759,328.

nd reproducer. A corona discharge modulating potential applied to it ndently of at least one of two dis- members. Irving Wolff, assigned C.A. No. 1,758,993.

Audio Frequency Circuits

Microphone and amplifier. A combination of a microphone transmitter and an audio frequency amplifier, and an energizing circuit for the microphone which is in series with the plate circuit of the tube and the amplifier. Lincoln Thompson, assigned to Wm. H. Bristol, Talking Picture Corporation, Waterbury, Conn. No. 1,760,672.

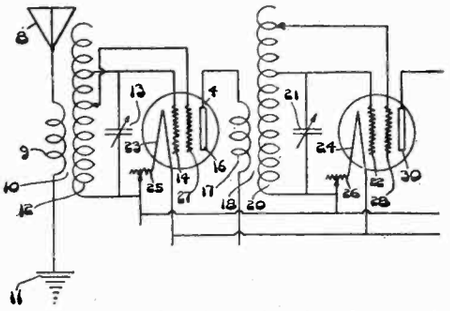
Audio frequency amplifier. A transformer coupled amplifier in which the grids of the respective tubes are maintained at a negative potential substantially equal to the peak value of the signal voltage and above the battery potential. Walter Van B. Roberts, assigned to R.C.A. No. 1,759,631.

Audio frequency amplifier. An amplifier in which it is possible to affect the high frequencies without varying the amplification at low frequencies and vice versa. Roy W. Harvey, Chicago, Ill. No. 1,761,626.

Amplifier. A sort of push-pull amplifier in which each side of the circuit consists of two tubes connected through transformers to each other and finally into the output transformer. A loud speaker is provided for each of the circuits. Leon F. Douglass, Menlo Park, Cal. No. 1,760,821.

Radio Circuits

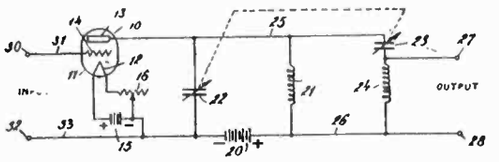
Radio transmitter. A master-oscillator, power-amplifier system. Normally, the grid potential to the power amplifier is of such a value as to stop the flow of plate current. Then the negative bias is reduced to permit a flow of plate current and simultaneously the plate circuit of the master-oscillator is closed. Philip D. Zurian, assigned to Burgess Battery Company, Madison, Wis. No. 1,760,225.



Receiving circuit. A circuit employing double grid tubes. The two grids are connected to different portions of the input inductance. Guy F. Cornish, assigned to the Cincinnati Patent Engineering Company, Cincinnati, Ohio. No. 1,759,937.

Radio transmitter. Method of reducing fading of radio signals by tuning the receiver to a single, relatively narrow band of frequencies. At the transmitter, the frequency of the modulated carrier-wave is varied continuously and cyclically, so as to have values within the band of frequencies, to which the receiver is tuned. Alfred N. Goldsmith, assigned to R.C.A. No. 1,761,118.

Radio frequency amplifier. A typical two-stage tuned radio frequency amplifier, followed by a grid leak detector. Oscillations in the amplifier are prevented by connecting the grids of succeeding tubes to the filament circuits of another tube which has two filaments and a plate. The plate of this tube is connected to the lower end of the two radio frequency primaries. Samuel Cohen, Brooklyn, N. Y. No. 1,759,094.



Radio frequency coupling system. A coupling system in which highly-selective amplification and stable operation are secured. Carl E. Trube, assigned to Hazeltine Corporation. No. 1,762,431.

Radio compass. Method of combining a directional receiving antenna with a non-directional antenna in such a manner that the direction of incoming energy can be determined. Frederick A. Kolster, assigned to Federal Telegraph Company, San Francisco. No. 1,759,119.

Radio receiving circuit. A conventional tuned radio frequency amplifier in which the high potential ends of the inter-stage transformers are connected together by a capacity. The inductive reactance of the coupling circuit is high, compared to the capacity reactance. Henry J. Round, assigned to R.C.A. No. 1,759,593.

Receiving circuit. A regenerative receiver circuit of the tickler type. LeRoy G. Kellogg, assigned to Kellogg Switchboard & Supply Company. No. 1,759,853.

Radio receiver. A transformer-coupled tuned radio frequency amplifier in which is shunted across the grid and plate of each tube a circuit comprising an inductance in series with a fixed condenser, which in turn are shunted by a variable condenser. Byron B. Minnium, assigned to Story & Clark Radio Corporation, Chicago. No. 1,760,162.

Radio frequency amplifier. A reflexed amplifier. Orin E. Marvel, assigned to General Motors Radio Corporation, Dayton, Ohio. No. 1,761,530.

Radio frequency amplifier. Tuned radio frequency amplifier, including means for suppressing capacity coupling, and individual shields for each transformer, condenser and tubes. L. M. Hull, assigned to Radio Frequency Laboratories, Inc., Boonton, N. J. No. 1,760,872.

Radio frequency amplifier. A bridge circuit resembling the Rice neutralized amplifier which can be progressively unbalanced as the lower radio frequencies are reached, so that the amplifier will produce a consequent greater amplification. Byron B. Minnium, assigned to Story & Clark Radio Corpn. No. 1,762,186.

Radio receiver. Several tandem circuits, each tuned to a wave to be amplified, an amplifier arranged to transmit a relatively wide frequency band, and a method of preventing distortion of this

wave by connecting the plate of one tube to the grid of the following tube other than the next succeeding tube by means of a capacity. Sidney E. Anderson, assigned to W. E. Company. No. 1,762,945.

Directional receiver. A heterodyne receiver in which means are provided for independently adjusting phase of one of several received signals which are combined after separate de-modulation into a common signal circuit. Harold Tray Friis, assigned to W. E. Company. No. 1,762,974.

Signal clarifier. In series with the antenna and the antenna terminals of a radio receiver, is an electro-magnet, which, when abormally strong signals traverse the antenna, closes a magnetic circuit and apparently short-circuits the input to the receiver. Wm. I. Spangler, Carlton, Ohio. No. 1,763,270.

Coupling circuit. An inter-stage transformer in which the secondary is tuned to the desired signal as usual, but in which the primary is divided into two sections, one of which is resonant to a frequency lower than the lowest frequency within the desired range, and the second part of which transmits the higher frequencies. Carl E. Trube, assigned to Hazeltine Corporation, Jersey City, New Jersey. No. 1,763,380.

Non-oscillating amplifier. A circuit in which means are provided to prevent a highly selective and high amplification circuit from oscillating. Edward H. Loftin, assigned to R.C.A. No. 1,763,401.

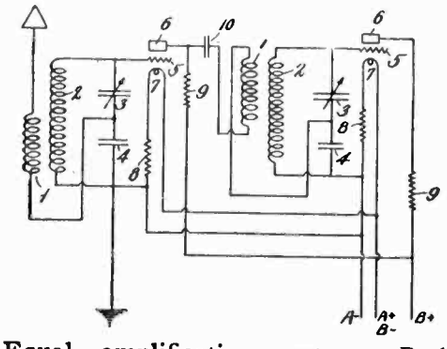
Interference preventer. A system whereby several frequencies, each subject to disturbance currents, are received, after which these various currents are combined so that the disturbances balance out. E. G. Gage, assigned to R.C.A. No. 1,758,940.

Neutralized amplifier. Radio frequency amplifier of the balanced bridge type whereby undesired retroactive capacity currents are balanced out. Lewis M. Hull, assigned to Radio Frequency Laboratories, Inc. No. 1,764,206.

Double detection receiver. A superheterodyne receiver. Joseph Bethenod, Paris, France. No. 1,763,947.

Regenerative receiver. Radio receiver in which regeneration is secured by several feed-back inductances coupled to the input circuit, one of which is more effective at low frequencies. V. D. Landon, assigned to Westinghouse E. & M. Co. No. 1,764,323.

Triple detection receiver. A superheterodyne receiver in which detection and combination of frequencies takes place three times instead of twice. Ralph Bown, assigned to A. T. & T. Co. No. 1,764,751.



Equal amplification system. Radio frequency amplifier in which coupling is both electrostatic and electromagnetic and in such proportion that the circuits are balanced as to undesired currents and transmit all frequencies substantially uniformly. Joseph Daley, assigned to Walter M. Cusick, Boston, Mass. No. 1,764,934.

Vacuum Tube Manufacturing, Etc.

Vacuum tubes. An elongated filament cathode coated with emission material varying from point to point along its length, whereby the current voltage characteristic is given a desired shape. Charles W. Carter, Jr., assigned to A. T. & T. Co. No. 1,762,212.

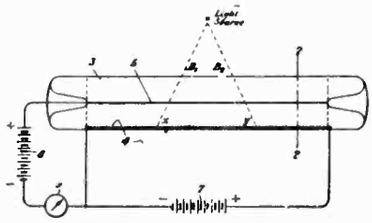


Photo-electric cell. A photo-electric cell responsive to the displacement of an incident light beam, comprising a light sensitive double terminal cathode of high ohmic resistance and an anode. Ralph K. Potter, assigned to A. T. & T. Company. No. 1,759,915.

Glow-lamp. Several cathode chambers each composed of a cathode having its interior surface to promote electron emission, each cathode insulated from the other and with a common anode. Percy L. Spencer, assigned to Old Colony Trust Company. No. 1,763,108.

Photo-electric tube. Photo-electric cells in which the anode is composed of a metal rod, the perpendicular distance from the cathode to anode being not over six times the diameter of the rod. Vladimir K. Zworykin, assigned to Westinghouse E. & M. Co. No. 1,763,207.

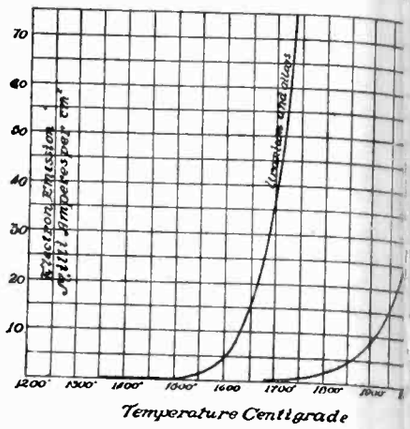
Gas-filling system. A method of regulating the flow of gas into a tube which has previously been exhausted of undesirable gases and which is to be filled with a new gas of desired quality and pressure. John A. Spencer, assigned to Raytheon, Inc., Cambridge, Mass. No. 1,763,107.

Electrical resistances. A conductive paint comprising a mixture of one part of colloidal graphite by volume with about 7 parts of waterglass by volume. The mixture is painted on an insulator and used as a fixed resistance. Lester L. Jones and Joseph A. Flanzer, assigned to Technidyne Corporation, New York. No. 1,762,990.

Electron emitting material. Method of activating a refractory incandescible cathode for emission purposes by enclosing it in an evacuated envelope with another electrode consisting in part of thorium. A sufficiently high temperature to partially vaporize the thorium is used when the thorium is sputtered from the electrode to the desired cathode. Clayton C. Ulrey, assigned to Westinghouse Lamp Company. No. 1,760,454.

Gas tube. A two-element tube, on one of which a quantity of metal of the cerium group is situated. A rare gas is within the envelope. Harvey C. Rentschler, assigned to Westinghouse Lamp Company. No. 1,760,524.

Vacuum tubes. An oxide coated filament tube in which is a second electrode composed of an alloy in chromium, the chromium conter of the surface of this electrode oxidized. Harvey C. Rentschl signed to Westinghouse Lamp pany. No. 1,760,526.



Electron emission material. M suitable for use as an electron e comprised of a refractory metal co ing approximately 93 per cent tun and approximately 7 per cent ura Harvey C. Rentschler, John W. M and Clayton C. Ulrey, assigned to inghouse Lamp Company. No. 1,76

Glow-tube measuring device. A strument for measuring elec phenomena comprising a vacuum of the usual type and a glow-tu series with the plate circuit. The s of supply for the circuit has a v above the starting voltage of the tube. Ernest E. Charlton, assign G. E. Company. No. 1,762,712.

Generation, Detection, E

Detector. A grid leak detector tem designed so that the output will approach the output level o same tube used as an amplifier. A denser shunted by a resistance in with the plate and the load of the accomplishes this result. Russe Ohl, assigned to A. T. & T. Com No. 1,760,957.

Modulation circuit. The grid b a tube is controlled at the signa quency. A series resonant circuit to the oscillation frequency is conn in parallel with the bias control, t vent influence upon this bias contr the generated oscillation. W Schaffer, assigned to Gesellschaf Drahtlose Telegraphie. No. 1,760,

Piezo-controlled generator. T two terminals of an inductance are nected the filament and plate vacuum tube. The grid is conn through the crystal to the variable ter tap of the inductance. On the side of the crystal is the usual gri connected to the filament. He Eberhard, Berlin, Germany. 1,761,882.

Rectifier. A two-element gas re in which the gas is monatomic cathode has a large area and the a small area, whereby a uni-direc electric discharge may be obtained. anode is composed of carbon in a stantially pure and gas-free con Harvey C. Rentschler, and Willia Merrymon, assigned to Westing Lamp Company. No. 1,760,525.

Polyphase current generator. cathode-ray tube, a means of defl the cathode beam onto terminals

PATENTS—

ected to the grids of the vacuum that a polyphase current is gen- Clinton W. Hough, assigned to ral Telegraph Co. No. 1,763,309.

d Recording Apparatus

electric pick-up. Mechanical on the surface of a Piezo crys- ates electrical oscillation. C. W. assigned to Federal Telegraph . No. 1,761,831.

recording apparatus. Method erring sound waves from a loud to a sensitive film. Ben J. assigned to Wired Radio, Inc. 6,220.

cal sound recorder. Charles assigned to Thomas A. Edi- No. 1,762,175.

recording lamp. A lamp com- a bulb formed in two chambers side by side and a capillary ng the two chambers, an elec- each chamber, and a circuit g the electrodes. Theodore W. igned to Case Research Labora- Ic., Auburn, New York. No.

recorder. Apparatus for photo- ically reproducing a sound record photographic film. Bernard Philadelphia, Pa. No. 1,759,580.

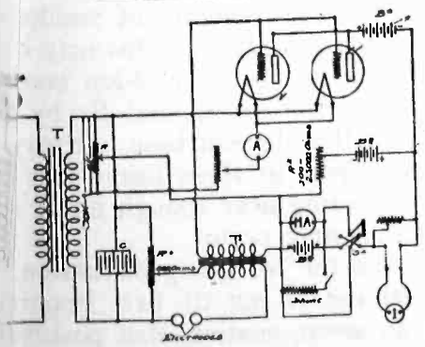
o-magnetic reproducer or re- Warren C. Jones, assigned to ephone Laboratories, Inc. No.

recorder. A system whereby a which is adapted for recording cs within a limited amplitude as applied to it electrical varia- ithin these recording limits. C. Mathes, assigned to Bell Tele- aboratories, Inc. No. 1,763,169.

eaneous Tube Applications

cronism indicator. Several sources e phase current produce poly- urrent, which in turn actuates uum tube circuit so that the lationship between the separate is indicated. W. A. Marrison, to Bell Telephone Laboratories, o. 1,762,725.

ity neutralized switch. Prevent- ansfer of high frequency energy an open mechanical switch of its capacitance by applying ly phased neutralizing energy dead side of the switch. A. B. n, assigned to R.C.A. No. 6.



cho-galvanic response device. odes are placed in contact with a being's skin, which are con- to the input of a sensitive ampli- The variations in resistance of the electrodes when the subject is under emotional strain are indicated on an output milliammeter. Starke R. Hathaway, Athens, Ohio. No. 1,761,476.

Biased amplifier. An amplifier in which a large biasing potential is put upon the grid of a tube to block the amplifier. A means is provided so that waves above a certain amplitude can reduce this biasing potential and render the amplifier operative. Olsen C. Dickerson, assigned to Bell Telephone Laboratories, Inc. No. 1,762,768.

Piezo-electric circuit. A circuit in which a crystal controls the frequency, but in which the crystal is not exposed to the entire voltage of the circuit. Walter Hahnemann, assigned to C. Lorenz Aktiengesellschaft, Berlin, Germany. No. 1,763,515.

Vacuum tube voltmeter. A voltmeter of a conventional type in which the steady plate current is bucked out by means of auxiliary batteries or resistances across the present batteries. Steven C. Hoare, assigned to G. E. Company. No. 1,760,597.

Protective arrangement. A circuit by which an electron tube acts as a protective device for an electric system. Waldemar Brückel, assigned to G. E. Company. No. 1,760,541.

Temperature regulating equipment. An element sensitive to heat is connected to the grid of the vacuum tube, in the plate of which is a relay circuit which allows more or less heat to flow into the circuit. John A. Payne, assigned to G. E. Company. No. 1,760,520.

Voltage variation eliminator. A system whereby variations in potentials supplied to the plate and the cathodes of a vacuum tube are eliminated by so increasing the cathode variations and introducing them at the proper phase into the plate circuit so that the variations existing there are balanced out. George B. Crouse, assigned to Conner Crouse Corporation. No. 1,759,545.

Radiation preventor. A bridge type vacuum tube circuit. Stuart Ballentine, assigned to Radio Frequency Laboratories, Inc. No. 1,760,871.

Interference reducer. Two antennas and receiving circuits are connected to a common indicating means. One of the antennas and circuits has a phase adjuster so that a low impedance to the flow of current will be had only when the signals have a pre-determined phase relation. Richard H. Ranger, assigned to R.C.A. No. 1,761,049.

Frequency changer. From current of one frequency, currents of another frequency are obtained. The second frequency is related to the first by a ratio which is not a single whole number. The new currents are obtained by a harmonic generator which changes the initial frequency to currents of a second sub-harmonic frequency, which is a common divisor of both the initial and the desired frequencies. Mendel Osmos, assigned to Gesellschaft für Drahtlose Telegraphie. No. 1,762,346.

Power supply circuit. Method of supplying filament and plate circuit of a vacuum tube from an alternating current source. Lars O. Grondahl, assigned to Union Switch & Signal Co. No. 1,763,097.

Regulator system. A series of patents all assigned to the Bell Telephone Laboratories or to the Western Electric Company and designed to maintain the voltage or some other characteristic of a circuit in a constant manner. No. 1,763,014; No. 1,763,016; No. 1,763,017; No. 1,763,057, and No. 1,762,999.

Wave analysis. Alfred S. Curtis, assigned to W. E. Company. No. 1,762,160.

Multiple amplifier circuit. A radio receiver composed of a number of amplifiers tuned to a separate frequency, all of which have a common input circuit. Any one of these amplifiers can be made to operate by closing the filament heating circuit. Ettore Bellini, Paris, France. No. 1,763,388.

Electric timing device. A vacuum tube in whose plate circuit is a glow tube connected across a condenser in series with a relay. Ernest E. Charlton, assigned to G. E. Company. No. 1,762,811.

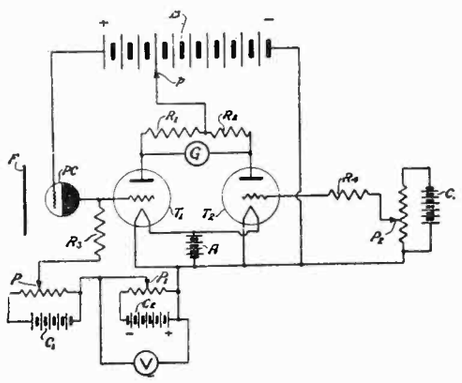


Photo-electric photometer. A photo-electric cell is connected to the grid of a tube which forms one arm of a Wheatstone bridge, which is normally balanced. A known voltage is then impressed upon the grid to bring the grid back to balance. H. A. Smith, assigned to Electrical Testing Laboratories, Inc. No. 1,762,748.

Television, Facsimile, Etc.

Picture transmission. Device for the electrical reception of pictures of the stop-start system. Otto Fulton, Bromley, England. No. 1,759,303.

Scanning system. A system in which the light goes through the center of a complex lens, thence on to a cylinder, where it is reflected back to a lens and into a photo-electric cell. Wilhelm Sheppmann, assigned to C. Lorenz Aktiengesellschaft, Berlin, Germany. No. 1,763,482.

Picture transmission system. A system in which a slit acts as a sort of scanning device. Frederick C. Crowe, Erie, Pa. No. 1,762,470.

Picture telegraphy. Henry J. Round, assigned to R.C.A. No. 1,759,594.

Television apparatus. A scanning system composed of several piezo-electric crystals, one of which vibrates along the vertical axis, and the other vibrates along a horizontal axis. Clinton W. Hough, assigned to Federal Telegraph Company. No. 1,760,198.

Picture transmission system. Robert C. Mathes, assigned to Bell Telephone Laboratories, Inc. No. 1,760,159.

Picture transmission. Frank Gray, assigned to Bell Telephone Laboratories, Inc. No. 1,759,504.

Transmission system. A single piezo-electric element carries a mirror and reflects impulses into a receptive system. Adolph A. Thomas, New York, N. Y. No. 1,760,383.

Chemical phenomena in coated filaments

[*Continued from page 180*]

heat of reaction—126,400 calories per gram molecule. as follows:

Heat of formation, in ergs $= 4.18 \times 10^7 \times 126{,}400$
Number of molecules per gram molecule $= 6 \times 10^{23}$

$$\text{Energy per molecule} = \frac{4.18 \times 1.264 \times 10^{12}}{6 \times 10^{23}} = .87 \times 10^{-11} \text{ ergs}$$

This value is only approximate since it neglects temperature coefficients of energy change, but the results are near enough to compare to energy values that are obtained in positive ion bombardment.

CO_2 is the usual bombarding molecule. If it carries unit charge (1.6×10^{-19} coulombs), and falls through a potential difference of 100 volts, its kinetic energy is $Ve = 100 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-17}$ watt-seconds or 1.6×10^{-10} ergs.

It is evident from the foregoing calculations that, under usual aging conditions, the residual gas in a tube does possess sufficient kinetic energy when ionized, to decompose BaO if we may assume that the entire energy of the positive ion, acquired in the travel between anode and cathode, is available for the purpose. Since the plate voltages usually are much higher than 100 volts, it is quite probable that sufficient energy for the decomposition is available.

The question of the fate of the CO_2 arises. No $BaCO_3$ may form from the BaO + CO_2 collision since, as previously pointed out, we have gone below the dissociation pressure of $BaCO_3$ at filament temperatures, in the exhausting of the tube. Furthermore, the energy of impact of the CO_2 on the filament is greatly in excess of the amount required to decompose CO_2 into C + O_2, and the molecule is therefore decomposed. The liberated oxygen may escape in part and combine with the getter or be absorbed elsewhere in the tube structure. The carbon may react with more CO_2 to produce CO according to the equation C + CO_2 = 2 CO.

When carbonaceous material is used in the coating, isolated carbon spots may occur, and form BaC_2 and SrC_2. Apparently all of these reactions occur, for CO is known to occur in tubes where carbonate coatings have been used, and acetylene, which results from the action of water on barium or strontium carbides, is frequently detectable by its odor when a tube is broken open in moist air. It is probable that most of the BaC_2 or SrC_2 that may have been formed was again decomposed to metallic Ba and Sr since the carbides are much more easily decomposed than are the oxides. It is equally probable that little, if any, of this elementary Ba and Sr may remain on the surface of the coating because of its very high vapor tension at operating temperatures.

There remains the stream of electrons—originally merely hot body emission from a relatively inactive cathode—which may be considered as a factor in the activation of the coating. In this case we may regard the stream of electrons as a current that flows between cathode and anode instead of as a group of material particles with high kinetic energy. Both points of view are correct and lead to the same result, but the method of attack chosen is the more convenient.

Both BaO and SrO are fairly good conductors of electricity at high temperatures. Even if most of the conductivity is of the first order, or metallic, instead of second order, or electrolytic—which is the usual method of oxide conduction, an electrolytic action necessarily takes place because the decomposition voltages of and SrO are both well below 10 volts. In this Ba and Sr would deposit as an alloy on the fila surface and not on the coating surface, since the ment is the negative pole in the circuit and the ba and strontium are positively charged ions.

A —280 filament from an active tube that had in use for about 50 hours was stripped of its co mechanically, then washed with water and dilute a acid to remove all remaining barium and stron oxides and carbonates. When rinsed and placed in tilled water to which a drop of phenolphthalein solu had been added, a very slow evolution of violet resulted, indicating the formation of a free alkali, w could only come from Ba or Sr that had diffused the surface of the metal of the filament. This ac has been found on nickel and silico nickel, but was r convincing on nichrome, since in this case the sur film of Ni and Cr oxide that was preformed on filament to cause the coating to adhere, was enti stripped off by the coating after some 50 hours, left only a bright metallic surface behind. This br metal was washed as mentioned above, and still g indications of Ba and Sr.

Electrolysis would cause this film of active mate to deposit on any filament base so long as good con was obtained.

It at once becomes evident that while electrolysis m be the source of the active material, it cannot possi continue to be the major element in electron trans from coating exterior to filament base since ionic mo ity is too low in a solid to permit such a large ene transfer as takes place in a power tube. It is m probable that as is the case in any electrolysis wh slow-moving ions are involved, that those ions wh are in immediate contact with the filament metal the ones that are discharged and become Ba and atoms. Polarization follows the exhausting of available ions. This would account for the rapid crease in emissivity of a filament during aging, up t certain limit, beyond which the rate decreases and s ceases to bring about further change.

Tube life vs. evaporation

Since the source of Ba and Sr is now exhausted least temporarily, the life of the tube is a question of relative values of the rate of loss of active material evaporation, and the rate of replenishment by el trolysis or bombardment. Since the rate of evaporat is a function of filament temperature it necessarily f lows that increasing the temperature decreases the use life of the tube, while it temporarily increases emission.

It is also known that a small amount of residual will increase the useful life of a tube. This may be to decomposition of BaO and SrO by +ion bomba ment and consequent increase of Ba and Sr by th collisions that occur near the filament base. It may a be that the mechanical impact of these heavy ions ac ally pushes particles of coating near enough to the m so that electrolytic action may occur.

We may conclude from the foregoing discussion, t the metal used as filament is not of first importa in the production of an active coating, that positive bombardment may bring about activation, and that e trolysis is probably the most important factor of all the initial production of the active surface.

Bibliography Int. Critical Tables.(1) Vol. III p. 204. (2) Ta Treatise on Physical Chemistry, 1925, p. 971.